US Army Corps
Of Engineers
Albuquerque District

SECTION 1135 PROGRAM

**DETAILED PROJECT REPORT AND
ENVIRONMENTAL ASSESSMENT FOR**

RIPARIAN AND WETLAND RESTORATION, PUEBLO OF SANTA ANA RESERVATION, NEW MEXICO

February 2002

Prepared by

U.S. Army Corps of Engineers
Albuquerque District
4101 Jefferson Plaza NE
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In cooperation with

THE PUEBLO OF SANTA ANA

U.S. FISH & WILDLIFE SERVICE

AYRES ASSOCIATES

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Length	inches	25.4	millimeters
	feet	0.3048	meters
	miles	1.6093	kilometers
Area	acres	0.0407	hectares
	square miles	2.590	square kilometers
Volume	cubic yards	0.7646	cubic meters
	acre-feet	1,233.5	cubic meters
	acre-feet	325,851	gallons
Flow	cubic feet/second (cfs)	0.0283	cubic meters/second
Mass (weight)	tons (short ton)	0.9072	metric tons
Velocity	feet/second (fps)	0.3048	meters/second
Salinity	µSiemens/cm or µmhos/cm	0.32379	parts/million NaCl or mg/liter NaCl
Temperature	° Fahrenheit (°F)	(°F-32)/1.8	° Celsius (°C)

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U.S. ARMY CORPS OF ENGINEERS
ALBUQUERQUE DISTRICT

FINDING OF NO SIGNIFICANT IMPACT

RIPARIAN AND WETLAND RESTORATION, PUEBLO OF SANTA ANA RESERVATION, NEW MEXICO

(Section 1135 Ecosystem Restoration Program)

Due in part to sediment retention upstream of Jemez Canyon and Cochiti Dams, the Rio Grande channel through the Pueblo of Santa Ana Reservation has incised from 5 to 10 feet over the past 25 years. To arrest further degradation and maintain aquatic habitat values, the Corps of Engineers will install two grade restoration facilities (GRFs) within the channel. Each structure consists of sheetpile spanning the active channel and extending approximately 1.5 to 2 feet above the current bed elevation. A rip-rap apron extending 400 feet downstream from the sheetpile and sloped similarly to existing riffles would allow passage of small fish over the structures. At the downstream end of the reach, a bed sill composed of 2-inch-diameter, launchable gravel also would be installed to provide a transition from the stabilized and degrading portions of the channel. The project was planned in conjunction with the Pueblo of Santa Ana who will provide 25 percent of the estimated $6.67 M total project cost. All construction and access areas are on tribal lands.

Alternatives analyzed in detail during the feasibility study included the installation of three GRFs and the no-action alternative. Without installation of grade control structures the river channel would continue to incise and aquatic habitat quality would be severely degraded. Three GRFs were not considered economically feasible.

The planned action would result in only minor and temporary impacts on air quality, water quality, and noise levels. The following elements have been analyzed and would not be significantly affected by the planned action: socioeconomic environment, air quality, water quality, noise levels, flood plains, riparian areas, wetlands, waters of the United States, biological resources, endangered and threatened species, prime and unique farmland, and cultural resources.

An Individual Permit pursuant to Section 404 of the Clean Water Act will be obtained following the final project design and prior to construction activities within waters of the United States. In accordance with the requirements of Executive Order 11988, Flood Plain Management, I have ensured to the maximum extent practicable that the risks of flood losses are minimized and the natural and beneficial values served by flood plains will be restored and preserved.

The planned action has been fully coordinated with Federal, tribal, and local governments with jurisdiction over the ecological, cultural, and hydrologic resources of the project area. Based upon these factors and others discussed in detail in the Detailed Project Report/ Environmental Assessment, the planned action would not have a significant effect on the human environment. Therefore, an Environmental Impact Statement will not be prepared for the conduct of the subject Section 1135 ecosystem restoration project.

20 Feb 02
Date

~~Gregory J. Gunter~~
Gregory J. Gunter
Major, EN
Acting District Engineer

CERTIFICATION OF LEGAL REVIEW

The Detailed Project Report for **Riparian and Wetland Restoration, Pueblo of Santa Ana Reservation, New Mexico**, including all associated documents required by the National Environmental Policy Act, has been fully reviewed by the Office of Counsel, Albuquerque District, and is approved as legally sufficient.

Darrell R. Riekenberg
Darrell R. Riekenberg
District Counsel

8 Feb 2002
Date

<u>DISTRICT ENGINEERS QUALITY CONTROL CERTIFICATION</u>

COMPLETION OF QUALITY CONTROL ACTIVITIES

The District has completed the (<u>Detailed Project Report and Environmental Assessment for the Riparian and Wetland Restoration Pueblo of Santa Ana Section 1135 project</u>). Certification is hereby given that all quality control activities defined in the Quality Control Plan appropriate to the level of risk and complexity inherent in the product have been completed. Documentation of the quality control process is enclosed.

GENERAL FINDINGS

Compliance with clearly established policy principles and procedures, utilizing clearly justified and valid assumptions, have been verified. This includes assumptions; methods, procedures and materials used in analyses; alternatives evaluated; the appropriateness of data used and level of data obtained; and the reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing Corps policy. The undersigned recommends certification of the quality control process for this product.

J. A. White for
Chief, Civil Works Project Management

Feb 14, 02
(Date)

QUALITY CONTROL CERTIFICATION

As noted above, all issues and concerns resulting from technical review of the product have been resolved. The project may proceed to the (plans and specifications phase).

District Commander

14 Feb 02
(Date)

DETAILED PROJECT REPORT AND ENVIRONMENTAL ASSESSMENT FOR

**RIPARIAN AND WETLAND RESTORATION,
PUEBLO OF SANTA ANA RESERVATION, NEW MEXICO**

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DETAILED PROJECT REPORT
AND ENVIRONMENTAL ASSESSMENT FOR

RIPARIAN AND WETLAND RESTORATION,
PUEBLO OF SANTA ANA RESERVATION, NEW MEXICO

1. BACKGROUND, PURPOSE, AND NEED

1.01 STUDY AUTHORITY

This feasibility study was conducted under the authority of Section 1135(b) of the Water Resources Development Act of 1986 (Public Law 99-662), as amended[1]. The objective of this authority is to improve the quality of the environment through modification of the structure or operation of existing water resources projects constructed by the U.S. Army Corps of Engineers, providing such modifications are feasible and consistent with the original project purpose. Improvements in ecosystem structure or function in areas adversely affected by such projects are also included in this authority.

1.02 PROBLEM IDENTIFICATION

River systems and their attendant wetland and riparian woodland communities provide significant resources for both humans and wildlife in the semi-arid western United States. Water resource management activities (diversions, dams, levees, drains, channelization, jetty jacks) by Federal and other entities have altered the hydrologic, ecologic, and sediment transport characteristics of the Rio Grande within New Mexico. Jemez Canyon and Cochiti Dams, operated for flood and sediment control by the U.S. Army Corps of Engineers, have contributed, in part, to the degradation of ecosystem functions and values.

Along the approximately 5 miles of the Rio Grande within the Pueblo of Santa Ana Reservation, several hydrologic and ecologic problems have been identified:

- The historically broad channel has incised up to 10 feet during the past 25 years, resulting in a narrow, entrenched channel;

- The extent and quality of aquatic habitat for native fish has deteriorated due to increased water depth and velocity;

- Channel incision has resulted in lowering the local water table in certain locations;

- The lack of inundation, scouring, and sediment deposition within the "bosque" (riparian woodland) has curtailed native cottonwood and willow seedling recruitment;

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[1] Amended by Section 304 of WRDA 1990 (P.L. 101-640), Section 202 of WRDA 1992 (P.L. 102-580), Section 204 of WRDA 1996 (P.L. 104-303), Section 506 of WRDA 1999 (P.L. 106-53), and Section 210c of WRDA 2000 (P.L. 106-541).

- Widespread invasion of non-native salt cedar and Russian olive trees has decreased the value of wildlife habitat and increased the threat of damaging fire.

In response to these problems, the Pueblo of Santa Ana initiated, in 1996, a restoration plan encompassing approximately 1,200 acres of riparian communities adjacent to the Rio Grande. The Pueblo has discontinued livestock grazing in the area and manages it as a nature preserve. Baseline vegetation, soil, and hydrologic data have been compiled. To date, non-native salt cedar and Russian olive have been removed from approximately 480 acres, and additional treatment is anticipated in 2002. Revegetation of cleared areas with native riparian tree and shrub species has been accomplished on 30 acres, and will expand over the next several years. Remediation of nearly 115 acres of saline and sodic soils was accomplished to facilitate successful planting of native grassland vegetation. In addition, the Pueblo has removed 1,600 obsolete Kellner jetty-jacks from the abandoned floodplain adjacent to the river. Monitoring is being conducted to document the response of plant and wildlife species to the various riparian restoration activities.

The Pueblo has been assisted in implementing their overall restoration plan by several agencies. The Bureau of Indian Affairs and the U.S. Environmental Protection Agency provided financial assistance in clearing non-native vegetation for the purpose of fire management and habitat improvement. The U.S. Fish and Wildlife service provided funding towards soil, wildlife, and vegetation surveys, and native riparian vegetation plantings.

In 1998, the U.S. Bureau of Reclamation (Reclamation) investigated routine bank stabilization measures where active bank erosion persistently threatened the riverside levee on the east side of the Rio Grande about 0.5 mile downstream of the Jemez River confluence. Rather than continue long-term maintenance, a more permanent solution to the problem was sought in coordination with the Pueblo of Santa Ana. Under their River Maintenance Program, Reclamation will restore riverine habitat in the 2-mile reach near the Jemez River confluence through the creation of a wider operational channel and floodplain, resulting in reduced water velocities, decreased flow depth, increased width-to-depth ratios, and increased sediment deposition. The project consists of three phases to be implemented over 3 to 5 years.

In Phase 1 (which is nearly complete at the time of this writing), the river channel has been realigned to direct flow away from the presently deteriorating east-side levee bank. Two portions of the former channel were retained as backwater areas, and bio-engineered bank stabilization along the new channel alignment was installed. A gradient restoration facility (GRF) including a 500-foot-long fish-passage apron has been installed approximately 4 miles upstream of the New Mexico Highway 550 bridge. An adjacent overbank area was lowered to facilitate inundation by flows with a return frequency of 2 to 5 years. Phases 2 and 3 will consist of planting 45 acres on bank lines, backwater areas, and floodplain zones with coyote willow, black willow and Rio Grande cottonwood.

The U.S. Army Corps of Engineers has been closely coordinating with the Pueblo, Reclamation, and other agencies to continue necessary channel stabilization and restoration measures. In October 1998, the Pueblo of Santa Ana signed a letter of intent to cost share the activities outlined in a jointly prepared Section 1135 program Preliminary Restoration Plan. Initiation of the present feasibility study was approved by Corps Headquarters in December 1998.

1.03 STUDY PURPOSE AND SCOPE

The purpose of this Section 1135 Program feasibility study was to investigate and recommend cost-effective environmental quality improvements along the Rio Grande within the Pueblo of Santa Ana Reservation. Restoration of ecosystem functions and values was evaluated within riverine, riparian, and wetland communities. This Detailed Project Report/Environmental Assessment (DPR/EA) addresses only those activities proposed for implementation by the Corps of Engineers under the Section 1135 Program.

1.04 REGULATORY COMPLIANCE

This document was prepared by the U.S. Army Corps of Engineers, Albuquerque District, in compliance with all applicable Federal statutes, regulations, and Executive Orders, including:

National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 *et seq*.);
Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500 *et seq*.);
U.S. Army Corps of Engineers' Procedures for Implementing NEPA (33 CFR 230);
Clean Air Act, as amended (42 U.S.C. 7401 *et seq*.);
Clean Water Act of 1977, as amended (33 U.S.C. 1251 *et seq*.);
Endangered Species Act, as amended (16 U.S.C. 1531 *et seq*.);
Fish and Wildlife Coordination Act (16 U.S.C. 661 *et seq*.);
Floodplain Management (Executive Order 11988);
Protection of Wetlands (Executive Order 11990).
National Historic Preservation Act, as amended (16 U.S.C. 470 *et seq*.);
Protection of Historic and Cultural Properties (36 CFR 800 *et seq*.);
Protection and Enhancement of the Cultural Environment (Executive Order 11593);
American Indian Religious Freedom Act (42 U.S.C. 1996); and
Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. 3001 *et seq*.).

2. EXISTING ENVIRONMENTAL SETTING

2.01 STUDY AREA LOCATION

The general study area includes the 5-mile-long reach of the Rio Grande within the Pueblo of Santa Ana Reservation, from the Jemez River confluence south to the NM Highway 550 (formerly Hwy. 44) bridge. The study area is within Sandoval County, New Mexico, and is immediately northwest of the town of Bernalillo.

2.02 PERTINENT WATER RESOURCE DEVELOPMENT PROJECTS

Cochiti Dam

The Cochiti Dam and Lake Project is located on the mainstem of the Rio Grande, about 50 miles north of Albuquerque and 25 river-miles upstream from the Pueblo of Santa Ana. The dam spans both the Rio Grande and the Santa Fe River near their confluence. The Flood Control Act of 1960 (P.L. 86-645) authorized the construction of Cochiti Dam for flood and sediment control. In 1964, P.L. 88-293 authorized the establishment of a permanent pool for the conservation and development of fish and wildlife resources and recreation purposes. The 1,200-acre pool was created, and is maintained, by allocations from the San Juan-Chama Project (trans-mountain diversion). Construction of Cochiti Dam began in 1965 by the Corps and the project was put in operation in 1975.

The reservoir's initial storage allocations included 105,000 acre-feet for sediment control and approximately 500,000 acre-feet for flood control. Between 1975 and 1998, Cochiti Lake has retained approximately 27,340 acre-feet of sediment.

Cochiti Dam is operated by the Corps within the authority of the Flood Control Act of 1960 (P.L. 86-645). Reservoir releases are restricted to the maximum non-damaging capacity of the downstream channel as measured at Albuquerque, approximately 7,000 cfs (USACE 1996). When inflow would exceed the channel capacity of the Rio Grande downstream, flood control storage is initiated. Floodwaters are stored only for the duration required and are evacuated as rapidly as downstream conditions permit. Operation of Cochiti Dam for flood control is coordinated with Jemez Canyon and Galisteo Dams in order to regulate for the maximum safe flow at Albuquerque.

Flood storage is normally associated with snowmelt runoff during April through June. Summer flood storage is generally the result of short-term, high intensity thunderstorm events. The maximum water storage to date has been 396,167 acre-feet (water surface elevation 5,434.5 feet), which occurred in 1987. This volume included the permanent pool and flood control storage pools.

Jemez Canyon Dam

The Jemez Canyon Dam and Reservoir Project is located on the Jemez River 2.8 miles upstream from its confluence with the Rio Grande. It is situated in Sandoval County, about 5 miles northwest of Bernalillo, New Mexico, and about 22 miles north of Albuquerque. The Jemez River enters the Rio Grande about 25 miles below Cochiti Dam.

Congressional authority for the construction of Jemez Canyon Dam is contained in the Flood Control Acts of 1948 (P.L. 80-858) and 1950 (P.L. 81-516). The facility regulates Jemez River flows for flood damage reduction and sediment retention. Construction of the dam began in May 1950, and it was completed and placed into operation in October 1953. All lands associated with the Jemez Canyon Dam and Reservoir Project (about 6,711 acres) are held in trust by the United States for the benefit and use of the Pueblo of Santa Ana. The Department of the Army and the Pueblo signed a Memorandum of Understanding (MOU) in 1952 (amended in 1978 by P.L. 95-498) which established a perpetual right and privilege for the construction, operation, and maintenance of the Jemez Canyon Dam and Reservoir Project. The Pueblo of Santa Ana reserved the right to use all associated lands for any purposes not inconsistent with those expressly granted to the Federal Government for the facility.

Jemez River flows passed through Jemez Canyon Dam are restricted to the maximum non-damaging capacity of the downstream channel of the Rio Grande, as measured at Albuquerque, approximately 7,000 cfs (USACE 1994). When the passage of inflow to the reservoir would exceed the channel capacity of the Rio Grande downstream, flood control storage is initiated. Flood waters are stored only for the duration needed to evacuate the water as rapidly as downstream conditions permit. Operation of Jemez Canyon Dam for flood control is coordinated with Cochiti and Galisteo Dams in order to regulate for the maximum safe flow at Albuquerque.

Flood storage is normally associated with snowmelt runoff during April through June. Summer flood storage is generally the result of short-term, high intensity thunderstorm events. The maximum storage to date has been 72,254 acre-feet (water surface elevation 5,220.3 feet), occurring in 1987.

At the time Jemez Canyon Dam was constructed, the Rio Grande downstream from the Jemez River confluence was an aggrading channel. By 1960, sufficient sediment had accumulated within the channel through Albuquerque to raise the river bed 6 to 8 feet above the typical valley floor elevation outside of the levee system (Lagasse 1980). In the spring of 1979, the Corps and the New Mexico Interstate Stream Commission (NMISC) established a sediment retention pool of about 2,000 acre-feet at Jemez Canyon Reservoir using water exchanged from the San Juan-Chama Project. This pool significantly improved the sediment retention. In January 1986 the sediment retention pool was expanded to include the entire unused capacity of the allocated sediment space (about 24,425 acre-feet) to further improve trap efficiency of the reservoir. The pool was created and maintained by capturing native water from the Jemez River in the reservoir and replacing that water to the Rio Grande by releasing San Juan-Chama Project water from upstream storage, usually during the spring runoff period. From closure in 1955 through 1998, Jemez Canyon Reservoir has retained approximately 19,800 acre-feet of sediment.

The Memorandum of Understanding (MOU) between the NMISC and the Corps concerning the establishment and maintenance of the sediment retention pool expired on December 31, 2000. The NMISC cited significantly increased demands on the available water in the region, it's increasing cost, and the need for increased sediment loading to the Rio Grande as factors in this decision. Approximately 12,000 acre-feet of the sediment retention pool was released in September through October, 2000 (USACE 2000), and the reservoir was completely evacuated in October 2001.

2.03 PHYSIOGRAPHY AND GEOLOGY

The study area lies along the Rio Grande and is within the Mexican Highland Section of the Basin and Range physiographic province (Fenneman 1931). The study area lies at the northern end of the Albuquerque Basin with Santa Ana Mesa to the northwest and the Sandia Mountains to the southeast. The geology of the area includes a broad rift valley with extensive Quaternary gravel terraces and sand deposits. West of the river, the bedrock is composed of Santa Fe formation sandstone overlain by mesas formed from numerous faults and several intrusive volcanic basalt flows (Chronic 1987). Elevation in the Bernalillo area averages about 5,050 feet.

2.04 SOILS

The substrate within the incised Rio Grande channel consists of sand and gravel alluvium with little soil profile development. Peralta loam and, less extensively, Trail loam are the prevalent soil series throughout the abandoned floodplain in the study area.

The Peralta series consists of very deep, somewhat poorly drained, moderately permeable soils forming in mixed alluvium on floodplains. Slopes are zero to three percent. Peralta loam is classified as a coarse-loamy, mixed, calcareous, mesic Typic Ustifluvents (NRCS 1999). Peralta soils are not listed as hydric by the National Technical Committee for Hydric Soils (NTCHS 1991). The soil is moist in some or all portions of March through October, and the depth to water table typically is 24 to 36 inches during this period. Typically, the depth to redoximorphic features (mottles) is from 12 to 30 inches and indicates the depth to the fluctuating water table and seasonally saturated soils above the water table (NRCS 1999).

Trail loam consists of very deep, moderately well-drained soils forming in stratified alluvium, predominantly from sandstone. Trail soils are classified as sandy, mixed, mesic Typic Torrifluvents. This soil series occurs on the Rio Grande floodplain, low terraces, and alluvial fans and is neither saline nor sodic. The soil occurs in thin strata of sandy loam, fine sandy loam, very fine sandy loam, loam, and silt loam. Runoff is slow and the permeability is moderately rapid. In these soils, the water table typically is 40 to 60 inches below the surface during the growing season. Trail soils are intermittently moist during periods from July to September and from December to February; the driest period occurs during May and June. The soil moisture regime is classified as Typic aridic (non-hydric).

2.05 CLIMATE

Climate of the study area is characterized as arid continental – hot summers with a large diurnal range in temperature. Winters vary from moderate in the lower basin to severe in the adjacent mountainous area. The spring and fall transition seasons are usually short. During the summer, northern New Mexico has a higher frequency of thunderstorms than most areas in the United States. Thunderstorms are most active during July and August and usually reach peak activity in late afternoon. Change from summer to winter is characterized by the disappearance of thunderstorm activity followed by clear weather, which dominates between winter frontal passages. The average growing season is about 165 days (NRCS 1999).

Since the installation of the weather station at Jemez Canyon Dam in 1954, the maximum annual precipitation was 13.88 inches in 1987 and the minimum was 2.40 inches in 1956. The maximum recorded 24-hour rainfall was 2.75 inches in October 1960. Mean annual precipitation at Bernalillo is 9.00 inches; mean monthly precipitation is given in Table 1. About one-third of the annual precipitation occurs during July and August as thunderstorms.

Table 1. Monthly temperature, precipitation, and evaporation at Bernalillo, New Mexico.

Month	Average daily minimum temp. (°F) [a]	Average daily maximum temp. (°F) [a]	Precipitation (inches) [a]	Evaporation (inches; Class A pan) [b]
January	19	49	0.45	2.98
February	22	55	0.46	4.50
March	28	63	0.57	7.67
April	35	72	0.51	9.73
May	43	81	0.64	12.67
June	51	91	0.49	14.48
July	59	94	1.40	13.74
August	57	91	1.54	11.68
September	49	84	0.99	9.50
October	37	73	0.94	6.88
November	25	59	0.49	4.12
December	19	50	0.51	2.97
Annual	37	72	9.00	100.92

[a] Data from NRCS (1999).
[b] Data from USACE (1994).

During the winter months, heavy snowfall occurs in the Jemez Mountains but snow is light over the study area. Snow remains in the mountainous areas above elevation 7,000 feet from December into April. Below 7,000 feet in elevation, snow seldom stays on the ground more than a few days. The average annual snowfall varies from 10 inches at Jemez Canyon Dam to over 100 inches in the mountains.

Surface winds, controlled by valley topography, are from the south in the summer and from the north in winter with annual wind velocity averaging about 10 miles per hour.

2.06 HYDROLOGY

Hydrology in the Middle Rio Grande valley (*i.e.*, Cochiti Lake to Elephant Butte Lake) follows a pattern of high flows during spring snowmelt runoff and low flows during the fall and winter months. Additional, short duration, high flows result from thunderstorms that occur in late summer months. The Middle Rio Grande hydrology has been altered due to the influence of flood control dams. Cochiti Dam primarily acts to decrease peak flows and has a much smaller impact on low flows; therefore, average annual flows have been less affected, while peak flows have been reduced. Average yearly hydrographs for pre- and post-Cochiti Dam periods are shown in Figure 1. It can be observed from annual hydrographs that the influence of Cochiti Dam has been to reduce the peak flows and extend the duration of the high flow period. Average winter base flows are somewhat larger during the post-dam period.

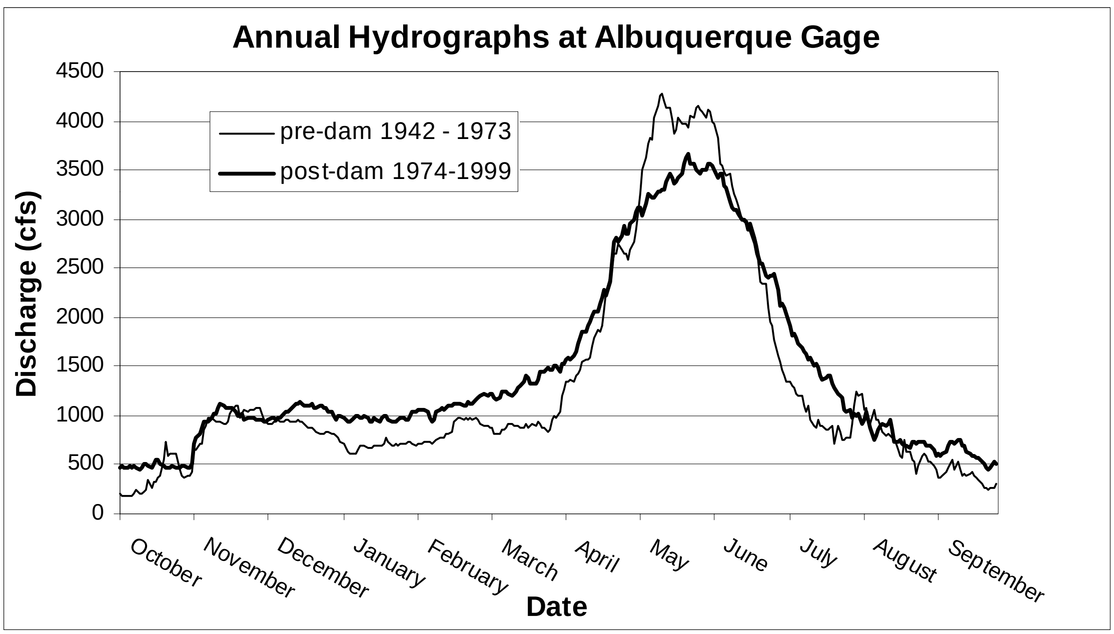

Figure 1. Average annual hydrograph at Albuquerque gaging station for pre- and post-Cochiti Dam periods. Drought years were removed from the pre-dam data. (USGS data compiled by Ayres Associates.)

Review of annual peak series data also exhibits the influence of flood control. Historical annual peak discharges recorded at the San Felipe gage illustrate the effects of regulation on the Rio Grande (Figure 2). From 1927 to 1945 floods in excess of 20,000 cfs were experienced approximately every five years. From 1945 to the construction of Cochiti Dam in 1973, floods in excess of 10,000 cfs were fairly common with the exception of drought years. Following construction of Cochiti Dam, regulation has prevented flows from exceeding 10,000 cfs. This has reduced the average annual peak discharge from 9,800 cfs to 5,700 cfs. A study to determine the effects of regulation on Middle Rio Grande flood hydrology was performed by the U.S. Bureau of Reclamation (USBR) Flood Hydrology Group (Bullard and Lane 1993). This study estimated return period floods at ten USGS gaging stations on the Middle Rio Grande. The study applied a procedure to develop discharge values for regulated (dam) and unregulated (no-dam) conditions. Table 2 summarizes the 2-, 5-, and 10-year discharges at the San Felipe and Albuquerque gaging stations as determined from this study.

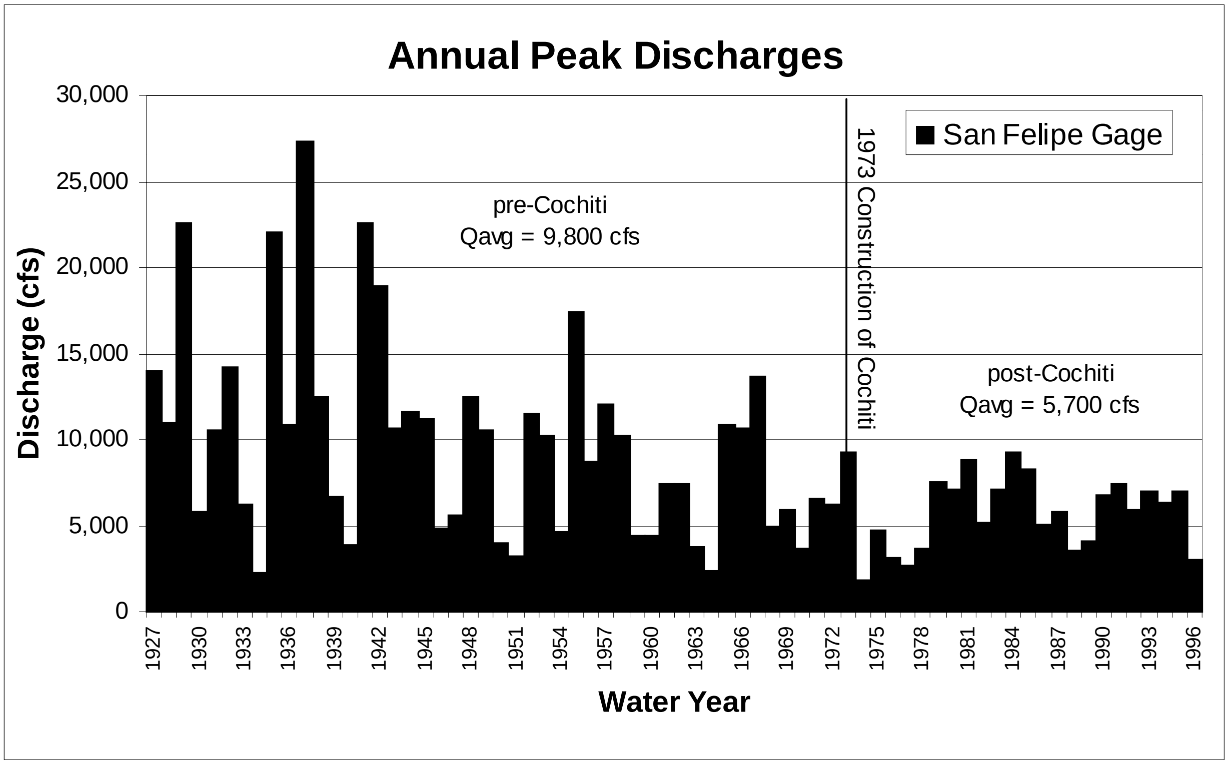

Figure 2. Annual peak discharges at the San Felipe gage.

Table 2. U.S. Bureau of Reclamation flood flow discharges (cfs) for regulated and unregulated conditions.

Return Period	San Felipe		Albuquerque	
	Unregulated	Regulated	Unregulated	Regulated
2-year	11,166	5,650	10,647	4,820
5-year	16,965	9,330	15,114	7,450
10-year	20,762	10,000	17,899	9,090

Flood control dams have acted to reduce flood flows by approximately a factor of two. This is significant with respect to geomorphology since channel-forming processes are assumed to be dominated by discharges within the range of these recurrence intervals. The Rio Grande study by Bullard and Lane (1993) included flood flow data up through 1988. An independent analysis including peak flows through 1996 verified that the data provided by Bullard and Lane is valid for the current conditions.

2.07 GEOMORPHOLOGY

A river channel's geometry and its adjustment to changing conditions are dependent on many factors. Discharge is the dominant variable that affects channel morphology but sediment transport, channel bed and bank material, and other hydrologic factors also are important influences.

Channel geometry results from a range of discharges over time, but it is convenient to select a single value for the basis of analysis and design. The channel-forming discharge used for river analysis and design has been variously termed the *bankfull*, *dominant* or *effective* discharge. Bankfull discharge has been equated with dominant discharge on the supposition that rivers adjust to the flow that just fills the available cross-section (from Knighton 1998). Dominant or effective discharge has been defined as the discharge that cumulatively performs the most sediment transport over time. In an incised stream the bankfull condition may only occur at low frequency events and therefore may not correspond to the dominant or effective discharge. The terms dominant discharge or effective discharge may be used interchangeably, but not necessarily with bankfull discharge. Leopold, Wolman, and Miller (1964) observed a correspondence between the frequency of the bankfull discharge and the discharge that cumulatively transports the most sediment. The supposed recurrence interval was in the range of 1 to 2 years. For this reason the 2-year discharge is frequently adopted as the effective discharge for river restoration projects.

An effective discharge calculation was completed for post-dam conditions in the Santa Ana reach to provide a basis for geomorphic comparisons and sediment transport calculations. Because this reach is incised, the term "bankfull" is problematic; therefore, the dominant/effective discharge was adopted for the analyses. The effective discharge calculated from the flow record at the San Felipe gage was approximately 6,000 cfs, and the value for the Albuquerque gage was 5,500 cfs. For the Santa Ana reach, the effective discharge was selected as 5,800 cfs, an average of the San Felipe and Albuquerque values. (This flow rate is slightly greater than the 2-year discharge of 5,400 cfs.)

Historically, the morphologic characteristics of the Middle Rio Grande channel were those of a wide and shallow river. The channel was described as a sand-bed stream (Nordin and Beverage 1965) with a braided pattern (Lane and Borland 1953) likely resulting from sediment overload (Woodson 1961). The river followed a pattern of scouring and filling during floods and was in an aggrading regime (*i.e.*, accumulating sediment). Flood hazards associated with the aggrading riverbed prompted the Middle Rio Grande Conservancy District to build levees along the floodway during the 1930s. However, the levee system confined the sediment and increased the rate of aggradation in the floodway. By 1960 the river channel near Albuquerque was 6 to 8 feet above the elevation of lands outside the levees (Lagasse 1980). Additional channel rectification works included Kellner jetty-jacks installed during the 1950s and 1960s for bank stabilization. Construction of dams at Jemez Canyon (1953), Abiquiu (1963), Galisteo Creek (1970), and Cochiti (1973) were expected to slow aggradation or reverse the trend and promote degradation in the Middle Rio Grande Valley. The flood control improvements have reduced the sediment load in the Middle Rio Grande and accomplished flood control objectives for much of the river valley.

The combined result of flood control and other water resource development projects has been significant channel degradation of the Rio Grande channel upstream from Bernalillo. In the Santa Ana reach, degradation has resulted in channel bed lowering and the virtual elimination of inundation of the historic floodplain. Hydraulic modeling revealed that the west bosque floodplain is approximately 4 feet above the current water surface elevation of the effective discharge of 5,800 cfs. Continued degradation is expected unless restoration alternatives are implemented.

Through the Santa Ana reach, a flattening of the riverbed slope has been the general trend since 1971 indicating that reduced sediment supply is the primary factor of degradation. The slope reduction results in a lowering of the channel bed from upstream to downstream as water entrains sediment from the channel bed and banks. Under the reduced sediment conditions this process continues until the sediment transport capacity equals that supplied from upstream. Alternatively, the degradation could stop if the channel becomes armored or structural controls are installed to stabilize the channel slope.

Lagasse (1980) provided an assessment of the initial response of the Rio Grande resulting from construction of Cochiti Dam. This study documented channel adjustments from Cochiti Dam to the Isleta Diversion after five years of establishing a permanent pool at Cochiti Lake. A recent study extended the analysis up through 1995 (Salazar 1998), but limited the analysis from Cochiti Dam to the Highway 550 bridge in Bernalillo. Both of these post-dam studies used comparative analyses of river planform, profile, cross section and sediment data to illustrate the degradational channel response to Cochiti Dam. The comparisons show a trend of channel narrowing and lowering of the riverbed. The following discussion extends the analysis through 1999 and summarizes additional quantitative analyses of hydrology, sediment and hydraulic properties through the Santa Ana reach.

The comparative analysis utilized cross section and sediment data from the "Middle Rio Grande Database" (Julien *et al.* 1999) which includes hydraulic geometry, discharge and sediment data for the Middle Rio Grande from pre-dam through 1999. Hydrologic data was obtained from the database and current discharge data was obtained from USGS gaging stations at San Felipe, Albuquerque and below Jemez Canyon Dam. The San Felipe gaging station is approximately 7.5 river-miles upstream of the Jemez River confluence and the Albuquerque gaging station is approximately 20 river-miles downstream of the Highway 550 bridge. The analysis for this study was limited to the Santa Ana reach from near the Jemez River confluence to just upstream of the Highway 550 bridge in Bernalillo. Aerial photographs from 1972 (pre-dam), 1982, 1991, 1992, 1994, and 1997 were used to review planform changes in the Santa Ana reach following construction of Cochiti Dam.

In 1972 the channel through the Santa Ana reach was braided, and the active channel occupied the full width between vegetated banks (about 500 to 600 feet). By 1982, the main channel exhibited some narrowing, especially near the confluence with the Jemez River. Planform changes were less marked downstream from the confluence. In the 1982 photograph, flooding (at an estimated discharge of 4,500 cfs) can be observed in the bosque floodplain west of the river, indicating the floodplain was hydrologically connected to the Rio Grande through surface flooding.

Aerial photography from 1991, 1992, 1994 display significant narrowing of the main channel throughout most of the Santa Ana reach with a braided pattern only near the downstream end of the reach. Channel degradation had cut through sand deposits to form split channels and mid-channel bars. By the early 1990s the channel appeared entrenched with a planform similar to today's. In the most recent aerial photography (1997), continued narrowing and entrenchment can be observed. Bars and islands observed on the 1992 photo have increased in size and some side channels have been abandoned. The photographs also indicate a potential for meandering, although at the small scale of the photography, the rate of migration does not appear rapid.

Comparisons of historical profiles and cross sections were used to analyze trends in channel morphology in the Santa Ana reach using the HEC-RAS hydraulic model (HEC 1998). Hydraulic models were developed using cross section data from 1971, 1975, 1986, 1992, 1995, and 1999. The post-dam effective discharge was used for comparative analysis of hydraulic variables.

A comparison of minimum channel elevation (thalweg) profiles is presented in Figure 3. The profiles indicate more than 10 feet of degradation at the upstream end of the reach and approximately 5 feet at the lower end since 1971. The profiles become flatter and slightly longer through time. The lengthening of the profiles results from meandering of the main channel. The channel lowering and decrease in channel slope are indicative of adjustment to the reduced sediment supply.

The channel slope has generally decreased from greater than 0.001 ft/ft to approximately 0.00085 ft/ft since construction of Cochiti Dam. A slight increase in the slope was observed from 1995 to 1999 which could be attributed to temporary adjustment to sediment inflows from tributaries and lower than average discharge in the Middle Rio Grande mainstem since 1995.

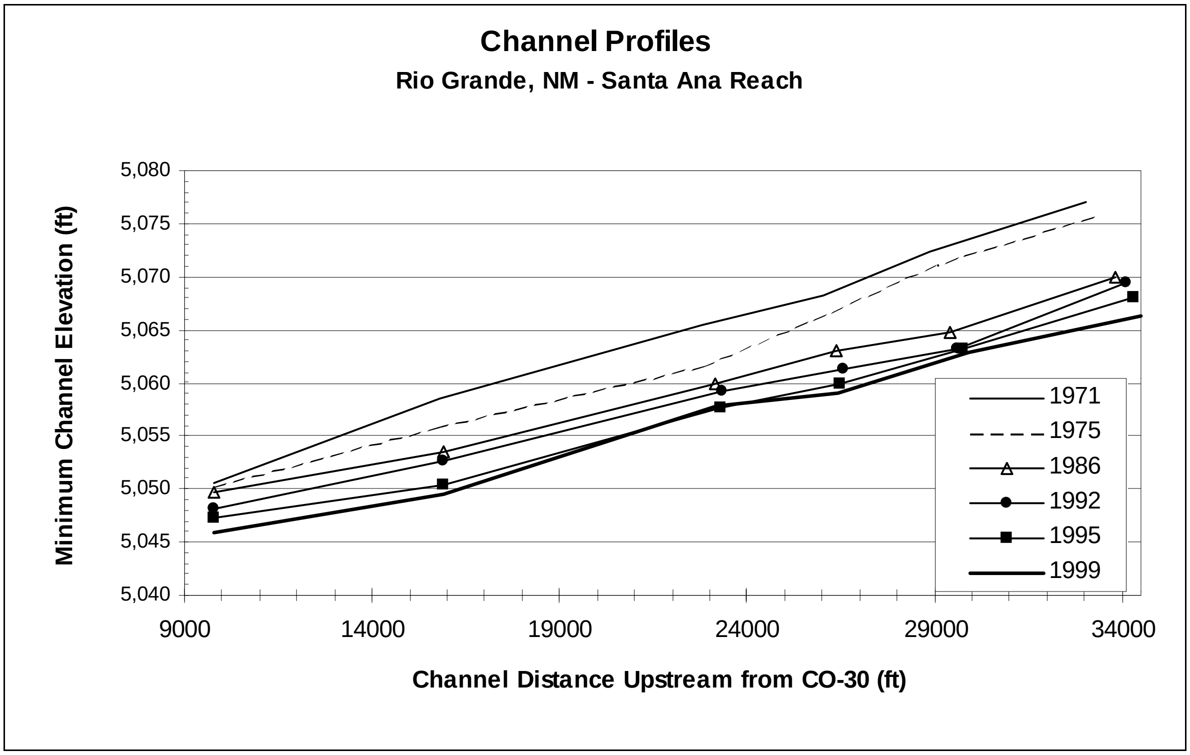

Figure 3. Historical channel profiles. (Elevation datum is NGVD).

Comparison of channel cross sections also illustrates the magnitude of degradation in the Santa Ana reach. Historical surveys of Cochiti Rangeline[2] CO-24 are presented in Figure 4. The transition from a wide shallow channel to the existing entrenched condition is clearly evident in the comparative cross sections.

[2] The Cochiti Dam aggradation/degradation rangelines referred to throughout this document are a series of cross-sections spanning the Rio Grande channel between Cochiti Dam and Elephant Butte Lake. The cross-sections are measured periodically to monitor changes in channel characteristics. Rangelines CO-24 through CO-30 are within or near the Santa Ana reach and the locations of several are shown on Plate 1. For reference, the approximate locations of rangelines and nearby structures are given below.

Approximate distance upstream from Cochiti rangeline CO-30.

Rangeline or feature	Distance (feet)	Distance (miles)
Angostura Diversion Dam	39,810	7.54
CO-24	34,530	6.54
Jemez River confluence	33,480	6.34
CO-26 (& GRF #1)	26,450	5.01
CO-27	23,220	4.40
CO-28	15,930	3.02
CO-29	9,830	1.86
US Highway 550 bridge	8,230	1.56
CO-30	0	0.00

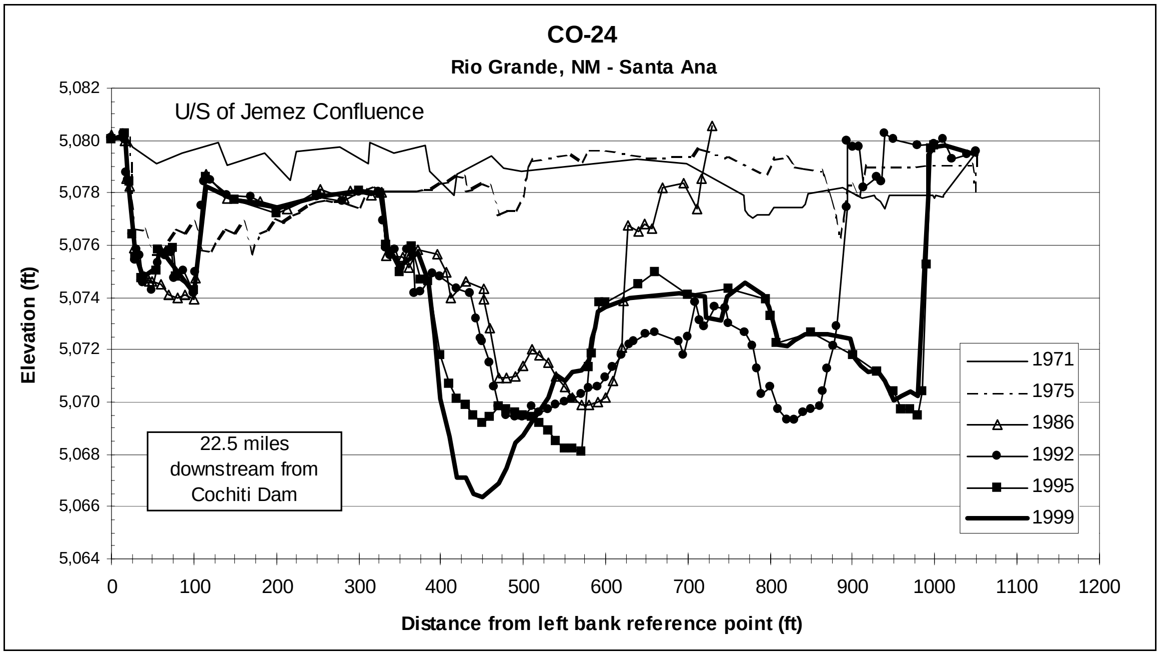

Figure 4. Historical cross sections at Cochiti Rangeline CO-24. (Elevation datum is NGVD).

Hydraulic variables at the post-dam effective discharge were averaged over the 5-mile-long Santa Ana reach from Cochiti Rangelines CO-24 to CO-29. A comparison of reach-averaged main channel hydraulic variables is shown in Figure 5. The effects of incision on hydraulics and channel geometry include decreased channel width and increased depth and velocity. This is significant to aquatic habitat in that fewer shallow, low-velocity areas are available for aquatic species. The effective channel width has decreased from approximately 600 feet to less than 300 feet. Simultaneously, the channel depth has increased by a factor of two. This translates into a significant decrease in the width-depth ratio (factor of four) a parameter used to describe the level of entrenchment.

Observation of historical suspended sediment data indicates significant reductions in sediment load following construction of flood control dams. Prior to construction of Cochiti Dam, the average annual suspended sediment load was on the order of 4 million tons per year. This has been reduced to an average of approximately 1 million tons per year.

Cross sections from 1975, 1986, 1992, 1995, and 1999 were compared to compute sediment losses since construction of Cochiti Dam. Comparison of the cross sections indicates that the Santa Ana reach has been losing approximately 140,000 tons of sediment per year from 1975 to 1995. Somewhat less degradation was experienced from 1995 to 1999 due to lower than average discharge during this period.

The riverbed material has generally become more coarse over time as fine sediments are trapped by dams upstream or removed from the channel bed downstream. Prior to dam construction the median bed material was on the order of 0.2 mm in size, which is indicative of fine sand. Recent bed material samples indicate a median size on the order of 7 to 20 mm which is in the gravel range.

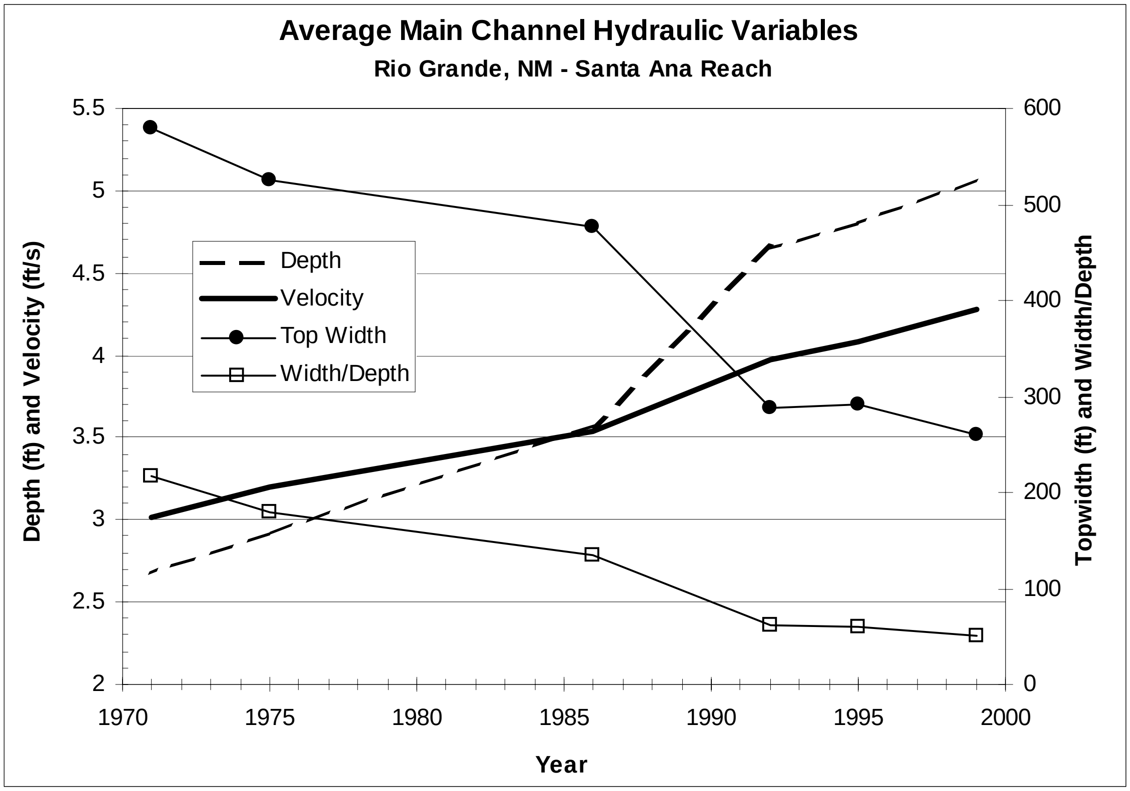

Figure 5. Reach-averaged channel hydraulic variables.

2.08 WATER QUALITY

Section 404 of the Clean Water Act provides for the protection of "waters of the United States" from impacts associated with irresponsible or unregulated discharges of dredged or fill material in aquatic habitats, including wetlands as defined under Section 404(b)(1). In New Mexico, permitting for placement of fill in such areas is the responsibility of the U.S. Army Corps of Engineers, Albuquerque District Regulatory Branch.

Section 401 of the Clean Water Act requires that a Water Quality Certification Permit be obtained for anticipated discharges associated with construction activities or other disturbance within waterways. Clean Water Act enforcement within the Pueblo of Santa Ana Reservation is the responsibility of the U.S. Environmental Protection Agency (EPA). No baseline numeric water quality standards have been established for tribal lands; however, the EPA commonly takes into consideration the standards set by neighboring governments when assessing water quality impacts.

From the southern boundary of the Pueblo of Santa Ana Reservation (near the Highway 550 bridge) to the northern boundary of the Pueblo of Sandia about 1.2 miles downstream, the State of New Mexico is responsible for water quality certification permits and standards. The New Mexico Water Quality Control Commission describes the designated uses for the Rio Grande from Angostura Diversion downstream to the Alameda Bridge in Albuquerque as irrigation, limited warmwater fishery, livestock watering, wildlife habitat, and secondary contact (20 NMAC 6.1; February 23, 2000). State regulations contain a qualitative general standard for turbidity: "Turbidity attributable to other than natural causes shall not reduce light transmission to the point that the normal growth, function, or reproduction of aquatic life is impaired or that will cause substantial visible contrast with the natural appearance of the water" (20 NMAC 6.1, Section 1105K).

Within the Pueblo of Sandia, designated uses along the Rio Grande include warmwater fishery, primary contact ceremonial use, secondary contact recreational use, agricultural water supply, and industrial water supply (Pueblo of Sandia 1993).

Numeric standards that must be maintained in surface waters downstream from the project area are listed in Table 3. Standards for metal and organic constituent concentrations are described in appropriate regulations (20 NMAC 6.1, Section 3100; Pueblo of Sandia 1993).

Table 3. Numeric water quality standards for physical and biological characteristics, and inorganic substances for the Rio Grande downstream from the project area.

Parameter	State of New Mexico [a]	Pueblo of Sandia [b]
Dissolved oxygen	> 5.0 mg/L	≥ 5.0 mg/L
pH	6.6 – 9.0	6.0 – 9.0
Temperature	< 90 °F	≤ 90 °F
Fecal coliform bacteria:		
Monthly geometric mean	< 200/100 mL	≤ 100/100 mL
Single sample	< 400/100 mL	≤ 200/100 mL
Total dissolved solids	< 1,500 mg/L [c]	–
Sulfate	< 500 mg/L [c]	–
Chloride	< 250 mg/L [c]	–
Total residual chlorine	–	≤ 0.011 mg/L
Turbidity	–	≤ 25 NTU

[a] 20 NMAC 6.1, Sections 2105.1 and 3100.
[b] Pueblo of Sandia (1993)
[c] Monthly average concentration at mean monthly flows above 100 cfs.

Section 402(p) of the Clean Water Act specifies that storm water discharges from construction sites must be authorized under the National Pollution Discharge Elimination System. Construction sites are defined as areas of clearing, grading, and excavation activities that disturb five or more acres of land. Prior to the start of construction, a Storm Water Pollution Prevention Plan must be prepared by the Federal Government or the construction contractor and a Notice of Intent would be filed with Region 6 of the Environmental Protection Agency.

2.09 AIR QUALITY AND NOISE

Sandoval County is within the Environmental Protection Agency's Air Quality Control Region 152 (State of New Mexico Region 2) (NMED 1997). The County is in attainment status for National Air Quality Standards for priority pollutants (particulate matter, sulfur oxides, nitrogen dioxide, carbon monoxide, ozone, and lead), meaning that ambient air quality meets or exceeds State and Federal standards. Generally, the only air pollutant of concern in the area is particulate matter (blowing dust during periods of high winds). In the State's Prevention of Significant Deterioration program administered by the New Mexico Environment Department, the region is designated Class II, which allows for moderate development and its associated air emissions. The nearest Mandatory Class I area from the Pueblo of Santa Ana is the Bandelier Wilderness Area, approximately 28 miles to the north.

Existing noise levels in the project area are very low, as is typical of rural locations. The major source of ambient noise is automobile, train, and air traffic.

2.10 ECOLOGICAL SETTING

Plant Communities

The study area lies within the Plains and Great Basin Grassland biotic community as defined by Brown and Lowe (1980). Vegetation typical of this community dominates the upland area west of the Rio Grande floodplain. Dominant species include black grama, New Mexico feathergrass, western wheatgrass, galleta, sand dropseed, ring muhly, four-wing saltbush, sand sagebrush, and sparsely distributed one-seed juniper (Dick-Peddie 1993). [Common and scientific names of plant and animal species are listed in the Fish and Wildlife Coordination Act Report contained in Appendix A.]

The Middle Rio Grande valley has one of the highest value riparian ecosystems remaining in the Southwest (Crawford *et al.* 1993). Historically, riparian plant communities were dominated by a cottonwood overstory, with a coyote willow and saltgrass-dominated understory. Less abundant riparian shrub species included New Mexico olive, seep-willow, false indigo bush, and wolfberry. Wetlands were common, frequently vegetated with cattails, sedges, spikerush, rushes, and yerba mansa (Scurlock 1998).

The existing riparian community in the Middle Rio Grande valley and in the project area is a result of alteration of the flow regime; drainage for agriculture and development; flood control; channelization and Kellner jetty jack fields; livestock grazing; beaver activity; and the establishment of exotic saltcedar and Russian olive. Wetlands no longer occur within the Santa Ana reach of the Rio Grande.

There are approximately 1,000 acres of riparian habitat bordering the river within the Pueblo of Santa Ana Reservation. A mature cottonwood overstory is present throughout approximately one third of this area. Saltcedar and Russian olive are common understory plants, replacing native vegetation such as cottonwood and coyote willow in many areas.

In accordance with their overall restoration plan, the Pueblo of Santa Ana has cleared non-native vegetation from nearly 480 acres on the west side of the Rio Grande, leaving large cottonwoods intact. Included in this endeavor was the complete removal of about 115 acres of dense saltcedar and the restoration of the area to a native salt-tolerant grassland. Russian olive and other shrub species were mechanically removed from the remaining area (which includes the west bank adjacent to all proposed grade restoration structure locations). The Pueblo will encourage natural establishment or specifically revegetate cleared bosque areas with a suite of native vegetation such as cottonwood and Gooding's willow, coyote willow, seepwillow, New Mexico olive and salt grass.

On the east side of the Rio Grande, riparian vegetation occupies a narrow (200 to 600 feet) strip between the river and levee. Throughout, woody vegetation is much less dense than on the west side of the channel. Russian olive and saltcedar are widely distributed, and less than half of the area contains a cottonwood overstory. The Pueblo expects to remove non-native woody species from this area in the future.

East of the bosque lies the Bernalillo Riverside Drain, and its attendant levee, maintained by the Middle Rio Grande Conservancy District. Agricultural fields and rural residences are present east of the levee.

<u>Fish</u>

Aquatic habitat in the Rio Grande has been altered by flood control dams, irrigation diversion dams, levees, jetty jack fields, and drainage for agriculture and development (Crawford *et al.* 1993). In the project area, the altered sediment and flow regimes have resulted in the transformation from a wide, braided sand-bed system to a single, incised, gravel-bed channel with no appreciable floodplain (USBR 1999). Wetlands and large slackwater areas are generally no longer available for aquatic organisms. The cold, clear water releases from Cochiti Dam and the entrenched channel with a gravel bed have created an aquatic system that favors cool-water fishes and invertebrates, and limits warmwater fisheries below the dam and downstream to Albuquerque. Consequently, the existing aquatic communities in the project area differ than those that occurred historically (Crawford *et al.* 1993).

The native ichthyofauna of the New Mexico portion of the Rio Grande is believed to have consisted of between 16 and 27 species (Hatch 1985; Smith and Miller 1986; and Propst *et al.* 1987), four of which were endemic to the basin. Of the latter, the Rio Grande shiner, phantom shiner, and Rio Grande bluntnose shiner no longer survive in the New Mexico portion of the Rio Grande. The Rio Grande silvery minnow is the only endemic Rio Grande fish surviving in New Mexico and now occupies less than 5 percent of its total former range (Bestgen and Platania 1991). The loss of many native fish species in the Middle Rio Grande illustrates that the hydrological, morphological, and ecological changes in the channel have had a major impact on aquatic resources.

Fish surveys have been conducted regularly in or near the project area by the Bureau of Reclamation, the U.S. Fish and Wildlife Service Fishery Resources Office, the New

Mexico Department of Game and Fish (NMDGF), and the University of New Mexico's (UNM) Biology Department. These surveys target the Rio Grande silvery minnow but provide information on other species as well. In September 1992, eight fish species were sampled at the New Mexico Highway 550 bridge and reported by UNM: western mosquitofish, white sucker, flathead chub, flathead minnow, red shiner, and Rio Grande silvery minnow, gizzard shad, and longnose dace. Western mosquitofish were the most abundant fish captured, followed by flathead chub, while longnose dace were the least abundant (Lang and Platania 1993). Six fish species were sampled in the Rio Grande immediately downstream of the New Mexico Highway 550 bridge crossing in February 1996 by NMDGF and UNM, including western mosquitofish, white sucker, flathead chub, flathead minnow, red shiner, and Rio Grande silvery minnow. Flathead chub were the most abundant, followed by Rio Grande silvery minnow, and flathead minnow. Red shiner and western mosquitofish were the least abundant (NMDGF 1997).

In July 1998, April 1999, and March-April 2000, the Service's Fishery Resources Office completed three surveys of fishes in the lower Rio Jemez and in Jemez Canyon reservoir in cooperation with the Pueblo of Santa Ana. One of the collection efforts yielded 21 Rio Grande silvery minnows, 1.3 percent of the fishes collected in the 3 surveys. Common carp was the most abundant fish, followed by white sucker and fathead minnows (USFWS 2000).

Wildlife

Hink and Ohmart (1984) performed systematic faunal surveys throughout the Middle Rio Grande valley, including portions of the Pueblo of Santa Ana Reservation. That report and additional observations by agency biologists form the basis of the following descriptions.

The largest mammal likely to occur in the area is the mule deer. Other mammals such as coyote, raccoon, beaver, muskrat, long-tailed weasel, bobcat, and striped skunk could be found in the project vicinity. Nuttall's and desert cottontails, black-tailed jackrabbit, rock squirrel, pocket gopher, deer mouse, western harvest mouse, white-throated woodrat, and American porcupine are also likely to occur in the project area.

Hink and Ohmart (1984) found that riparian areas are used extensively by most bird species in New Mexico. Cottonwood-dominated community types are used by large numbers of bird species, and are preferred habitat for a large proportion of the species, especially during the breeding season. Bird density appears to be strongly related to density of foliage, regardless of species composition of the plant community. Marshes, drains, and areas of open water contribute to the diversity of the riparian ecosystem as a whole because of their strong attraction to waterbirds. At various times of the year, riparian areas support the highest bird densities and species numbers in the Middle Rio Grande.

The Rio Grande in and near the project area provides habitat, on a seasonal basis, for a variety of waterbirds including Double-crested Cormorant, Canada Goose, Mallard, Gadwall, Green-winged Teal, and Northern Shoveler. Spotted Sandpiper and Killdeer breed along the Rio Grande channel. Raptors typical of northern New Mexico that may occur in the project area include the Bald Eagle, Turkey Vulture, Sharp-shinned Hawk, Cooper's Hawk, Red-tailed Hawk, American Kestrel, and Great Horned Owl. Other species known to be breeding in or near the riparian zone include Black-crowned Night-Heron, Black-chinned Hummingbird, Northern Flicker, Downy Woodpecker, Northern Rough-winged Swallow, Black-billed Magpie, Common Raven, White-breasted Nuthatch, American Robin, Spotted Towhee, Summer Tanager, Yellow-breasted Chat, Blue Grosbeak, Black-headed Grosbeak, and Song Sparrow. Game species in the area include Mourning Dove and Scaled Quail.

Most amphibians depend on aquatic habitat for at least a portion of their life cycle. Amphibians associated with wetter riparian areas, wet meadows, and marshes are chorus frogs, leopard frogs, and bullfrogs (Crawford *et al.* 1993). The presence of these species is limited in the project area by a lack of wet meadows or marshes. Amphibians common to the habitat types in the general project area (riparian and upland) include tiger salamander, New Mexico spadefoot, Great Plains toad, Woodhouse's toad, bullfrog, and northern leopard frog (Degenhardt *et al.* 1996).

Reptiles which may occur in the habitat types within and adjacent to the project area include the snapping turtle, spiny softshell, collared lizard, lesser earless lizard, shorthorned lizard, roundtail horned lizard, prairie lizard, little striped whiptail, New Mexico whiptail, Great Plains skink, ringneck snake, coachwhip, striped whipsnake, bullsnake, common garter snake, blackneck garter snake, smooth green snake, western diamondback rattlesnake, and prairie rattlesnake (Degenhardt *et al.* 1996).

2.11 ENDANGERED AND PROTECTED SPECIES

As the quality and quantity of the fish and wildlife habitat within the middle Rio Grande valley has decreased over time, so has its ability to sustain native flora and fauna. Several species endemic to the valley have been placed on the Federal threatened and endangered species list under the Endangered Species Act. Listed species that could potentially occur within the project area include the Rio Grande silvery minnow, Southwestern Willow Flycatcher, and Bald Eagle. No Federally-listed plant species are likely to occur within project area, and none have been detected by Corps of Engineers and Pueblo of Santa Ana biologists.

Rio Grande Silvery Minnow

The Rio Grande silvery minnow (*Hybognathus amarus*) was formerly one of the most widespread and abundant species in the Rio Grande basin of New Mexico, Texas, and Mexico (Bestgen and Platania 1991). At the time of it's listing as endangered, the silvery minnow was restricted to the Middle Rio Grande in New Mexico, occurring only from Cochiti Dam downstream to the headwaters of Elephant Butte Reservoir, only 5 percent of its historic range (Platania 1991). The Rio Grande silvery minnow was listed as federally endangered under the Endangered Species Act in July 1994 (USFWS 1994). The species is listed by the State of New Mexico as an endangered species, Group II. The U.S. Fish and Wildlife Service (Service) documented that de-watering of portions of the Rio Grande below Cochiti Dam through water regulation activities, the construction of main stream dams, the introduction of non-native competitor/predator species, and the degradation of water quality as possible causes for declines in Rio Grande silvery minnow abundance (USFWS 1993a).

Critical habitat for this species was designated in July 1999 (USFWS 1999a) and included the Rio Grande corridor from the New Mexico Highway 22 Bridge (immediately downstream from Cochiti Dam) to the railroad bridge near San Marcial, New Mexico, approximately 160 miles downstream. The Santa Ana reach is within that designated area. Constituent elements of critical habitat required to sustain the Rio Grande silvery minnow include stream morphology that supplies sufficient flowing water to provide food and cover needs for all life stages of the species; water quality to prevent water stagnation (elevated temperatures, decreased oxygen, etc.); and water quantity to prevent formation of isolated pools that restrict fish movement, foster increased predation by birds and aquatic predators, and congregate disease-causing pathogens (USFWS 199a). In November 2000, the U.S. District Court for the District of New Mexico issued an opinion that the designation of critical habitat for the Rio Grande silvery minnow was invalid[3]. The designation has been suspended pending preparation of an Environmental Impact Statement by the Service and the formulation of a new rule, expected in 2002.

The Rio Grande silvery minnow is a moderately sized, stout minnow, reaching 3.5 inches in total length, which spawns in the late spring and early summer, coinciding with high spring snowmelt flows (Sublette *et al.* 1990). Spawning also may be triggered by other high flow events such as spring and summer thunderstorms. This species is a pelagic spawner, producing neutrally buoyant eggs that drift downstream with the current (Platania 1995). As development occurs during the drift, which may last as long as a week depending on temperature and flow conditions, the larvae seek quiet waters off-channel. Platania (1995) found that eggs developed in 24 to 48 hours in a laboratory experiment. Taking into account the possible length of the drift, considerable distance could be traversed by the drifting, developing eggs (Sublette *et al.* 1990, Bestgen and Platania 1991, USFWS 1993a, Platania 1995). Maturity for this species is reached toward the end of the first year. Most individuals of this species live one year, with only a very small percentage reaching age two. It appears that the adults die after spawning (Sublette *et al.* 1990, Bestgen and Platania 1991, USFWS 1993a).

This reproductive strategy, where the progeny are moved downstream, may partially explain the greater abundance of the species in the San Acacia reach (San Acacia Diversion Dam to Elephant Butte Reservoir), as revealed by numerous fish collections (Bestgen and Platania 1991; Platania 1993). During recent surveys in 1999, over 95 percent of the Rio Grande silvery minnows captured occurred downstream of San Acacia Dam (Platania and Dudley 1999; Smith and Jackson 2000). In the past, the young drifted downstream, developed to maturity, and proceeded back upstream to occupy available habitat. The upstream migration is now blocked by mainstem dams, thus restricting the species' redistribution. Concurrently, a portion of the reproductive effort upstream of each dam is distributed downstream by the drift. Rio Grande silvery minnows that move into the San

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[3] *Middle Rio Grande Conservancy District, ex rel the State of New Mexico, the State Engineer, New Mexico Interstate Stream Commission, the New Mexico Attorney General, and Forest Guardians versus Bruce Babbitt et al., No. CIV 99-870, 99-872, and 99-1445M/RLP.*

Acacia reach (the majority of the population) are believed to be transported by high velocities in the narrow and deep channel into Elephant Butte Reservoir, where none survive (USBR 1999).

Natural habitat for the Rio Grande silvery minnow includes stream margins, side channels, and off-channel pools where water velocities are lower than in the main channel. Areas with detritus and algal-covered substrates are preferred. The lee sides of islands and debris piles often serve as good habitat. Stream reaches dominated by straight, narrow, incised channels with rapid flows would not typically be occupied by the Rio Grande silvery minnow (Sublette *et al.* 1990; Bestgen and Platania 1991).

In the proposed project area, past actions have reduced the total habitat from historic conditions and altered habitat conditions for the Rio Grande silvery minnow. Narrowing and deepening of the channel, lack of side channels and off-channel pools, and changes in natural flow regimes have all adversely affected the Rio Grande silvery minnow and its habitat. These environmental changes have degraded spawning, nursery, feeding, resting, and refugia areas required for species survival and recovery (USFWS 1993a). In addition, Angostura Diversion Dam directly upstream of the project area blocks upstream migration and restricts species redistribution. Cochiti Dam, approximately 25 miles upstream of the project area, also acts as a barrier. Recent fish collections and habitat surveys have demonstrated that habitat through the Santa Ana reach of the Rio Grande is poor for the silvery minnow. The coarser substrate, deeper channel, and higher velocities that occur in the incised channel downstream of the dams do not provide the conditions where greater numbers of Rio Grande silvery minnows are known to occur.

Within the Pueblo of Santa Ana Reservation, the minnow is known to occupy the Rio Grande and the Jemez River downstream from Jemez Canyon Dam. Surveys conducted by the Pueblo of Santa Ana and the USFWS Fishery Resource Office along the lower Jemez River in May 2000, netted 21 adult silvery minnows. A portion of this reach immediately downstream from the dam has flood-prone benches which may provide suitable slackwater refugia for minnows during high discharges. The lower portion of the reach is incised and lacks slackwater areas. Silvery minnows likely are present in the lower Jemez River opportunistically during relatively low-flow periods; higher discharges would move the fish downstream to the Rio Grande. Only a single silvery minnow has been captured during monthly surveys between February and August 2000 in the Rio Grande between Angostura Diversion and the Highway 550 bridge (survey data from the Bureau of Reclamation, the U.S. Fish and Wildlife, and the University of New Mexico). However, as many 22 individuals were encountered during surveys of the reach from the Highway 550 bridge downstream to the Corrales siphon.

<u>Southwestern Willow Flycatcher</u>

The Service listed the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) as endangered in February 1995 (USFWS 1995a). The flycatcher also is classified as endangered (Group I) by the State of New Mexico (NMDGF 1987). The current range of the flycatcher includes Arizona, New Mexico, southern California, western Texas, southwestern

Colorado, and southern portions of Nevada and Utah (Unitt 1987; Browning 1993). Critical habitat for the flycatcher was designated in July 1997; however, the proposed project area is not within designated critical habitat. In New Mexico, flycatchers are known to breed along the Rio Grande, Zuni, San Francisco, and Gila River drainages. Available habitat and overall numbers have declined statewide (USFWS 1997). A draft recovery plan for the flycatcher is currently available for public review.

Loss and modification of nesting habitat is the primary threat to this species (Phillips *et al.* 1964; Unitt 1987; and USFWS 1993b). Loss of habitat used during migration also threatens the flycatcher's survival. Large scale losses of southwestern wetland and cottonwood-willow riparian habitats used by the flycatcher have occurred (Phillips *et al.* 1964; Carothers 1977; Rea 1983; Johnson and Haight 1984; Howe and Knopf 1991).

The flycatcher is an obligate riparian species and nests in thickets associated with streams and other wetlands where dense growth of willow, buttonbush, boxelder, Russian olive, saltcedar, or other plants are present. Nests are frequently associated with an overstory of scattered cottonwood. Throughout the flycatcher's range, these riparian habitats are now rare, widely separated, and occur in small and/or linear patches. Flycatchers nest in thickets of trees and shrubs approximately 6 to 23 feet in height or taller, with a densely vegetated understory approximately 12 feet or more in height. Surface water or saturated soil is usually present beneath or next to occupied thickets (Phillips *et al.* 1964; Muiznieks *et al.* 1994). At some nest sites, surface water may be present early in the breeding season with only damp soil present by late June or early July (Muiznieks *et al.* 1994; Sferra *et al.* 1995). Habitats not selected for nesting include narrow (less than 30 feet wide) riparian strips, small willow patches, and stands with low stem density. Suitable habitat adjacent to high gradient streams does not appear to be used for nesting. Areas not utilized for nesting may still be used during migration.

Flycatchers begin arriving in New Mexico in late May and early June. Breeding activity begins immediately and young may fledge as soon as late June. Late nests and re-nesting attempts may not fledge young until late summer (Sogge and Tibbitts 1992; Sogge *et al.* 1993).

Occupied and potential flycatcher nesting habitat occurs within the Middle Rio Grande valley: 30 breeding pairs were identified in 1999 surveys, and approximately 45 pairs were found in 2000. Occupied and potential habitat is primarily composed of riparian shrubs and trees, chiefly Goodding's willow and peachleaf willow, Rio Grande cottonwood, coyote willow, and saltcedar. The nearest known breeding flycatchers from the Pueblo of Santa Ana occur along the Rio Grande near San Juan Pueblo and Isleta Pueblo, 50 miles upstream and 35 miles downstream, respectively.

Much of the riparian habitat along the Rio Grande within the Pueblo of Santa Ana Reservation is not currently considered potential nesting habitat for the flycatcher (USBR 1999), although flycatchers may use the area during migration. Habitat in the area has mature cottonwoods, often bordered or mixed with saltcedar and Russian olive, with small patches of willows along the high flow channels. Ahlers and White (1996) reported that most of the mature riparian vegetation lacked understory structure and density and is unsuitable habitat for the flycatcher. In addition, wetlands and vegetated backwater habitats are currently lacking in the project area. No flycatchers were observed on selected bars and banklines in the project area during formal surveys in 1999 (USBR 1999).

Dense riparian habitat formerly occupying the west side of the Rio Grande in the project area was considered potential Southwestern Willow Flycatcher habitat (BIA 2001). Biologists from the Bureau of Indian Affairs, Southern Pueblos Agency conducted formal surveys throughout the area in 2001. Four migrant Willow Flycatchers were observed early in the season, but no breeding individuals were present. The agency, therefore, concluded that the recently completed bosque restoration and fire management activities in the area would have no effect on this species.

Bald Eagle

The Bald Eagle (*Haliaeetus leucocephalus*) is a winter resident along rivers and at reservoirs in the southwestern United States. This species was listed as Federally endangered in 1967 (32 Federal Register 4001) and again in 1978 (43 Federal Register 6233), but recently was reclassified as threatened due to breeding population increases throughout the country (USFWS 1995b). The USFWS proposed removing the bald eagle from the list of endangered and threatened wildlife in July 1999 (USFWS 1999b); however, final delisting of the species has not yet occurred.

Adults of this species are easily recognized by their white heads and tails and dark bodies. Favored prey of Bald Eagles include fish, waterfowl, and small mammals. Bald eagles prefer to roost and perch in large trees near water. There are potential perch sites in the vicinity of the project area where large cottonwoods occur at the river’s edge.

Bald Eagles are known to be present along the Rio Grande and at Jemez Canyon Reservoir during the winter. (Although the pool at Jemez Canyon Reservoir has been evacuated, Bald Eagles continue to use the reservoir area for roosting and loafing.) Both adult and juvenile birds may be present in the project area between late November and early March.

The Corps conducted aerial surveys for Bald Eagles between 1988 and 1996 during January, the month of highest abundance. During the 8 years of survey, Bald Eagles were present at Jemez Canyon Reservoir during 4 years and the number of birds observed ranged from 0 to 3. The same frequency and maximum number of eagles were observed along the mainstem of the Rio Grande from the confluence of the Jemez River downstream to the Interstate 40 bridge at Albuquerque during the same survey period. The number of Bald Eagles observed along the Rio Grande from the Jemez River confluence north to and including Cochiti Lake was significantly higher (Table 4).

Table 4. Bald Eagle occurrence along the Rio Grande and major reservoirs during aerial surveys in January, 1988 to 1996, conducted by the Corps of Engineers.

Reach or reservoir	Number of years present	Mean (SD)	Min.	Max.
Rio Grande: I-40 Bridge (Albuq.) to Jemez River confluence	4	0.8 (1.0)	0	4
Jemez Canyon Reservoir	4	0.9 (1.1)	0	3
Rio Grande: Jemez River confl. to Cochiti Dam	8	12.6 (6.2)	3	23
Cochiti Lake	6	3.7 (5.8)	0	18

2.12 CULTURAL RESOURCES

Culture History

Culture history for Santa Ana Pueblo and generally for the middle Rio Grande area has been documented in numerous references such as White (1942), Cordell (1979, 1984, 1997), Ortiz (1979), Strong (1979), and Bayer (1994). The project area is located on Pueblo of Santa Ana Reservation land, in an agricultural area along the Rio Grande known as Ranchiit'u (El Ranchito, Ranchitos). The Ranchiit'u is within the Northern Rio Grande Region as archaeologically defined by Wendorf and Reed (1955) (Rodgers 1979, Cordell 1997, Penner *et al*. 2001). The culture history of the Southwest and the project area has been chronologically generalized into several classification schemes that utilize noticeable changes in the cultural record, as seen in temporal and spatial similarities and differences, to assist in the explanation and interpretation of the cultural record. The primary Periods and their approximate dates are as follows:

PaleoIndian:	ca. 11,500 B.P.- 7,500 B.P.
Archaic:	ca. 7,500 B.P.- 2,000 B.P.
Anasazi:	ca. 1 - 1540
Historic:	1540 - present

The PaleoIndian and Archaic Periods that are typically identified in the archaeological record by the presence of morphologically diagnostic projectile points. The end of the Archaic Period is difficult to define chronologically because the mobile hunting and gathering lifestyle continued in many areas into the Historic Period.

Generally in the Rio Grande Valley, the prehistoric era is characterized by increasing population sizes, movement of people across the landscape, more sedentism and aggregation of peoples into larger villages, an increasing dependence on agriculture, and a more intense and efficient use of the environment. Small pithouse villages, larger above-ground roomblocks, and huge adobe pueblos with scattered fieldhouses are common. There is an increasing use of water control methods and local and long distance trade is important.

In the Ranchiit'u area, the chronological Puebloan cultural sequence includes the Rio Grande Developmental (ca. 660-1200), the Coalition period (ca. 1200-1325), the Rio Grande Classic (ca. 1325-1600), and the Historic period dating from about 1600 to present (Rodgers 1979, Cordell 1997). The Pueblo of Santa Ana people, who call themselves "Tamayame" and their Pueblo "Tamaya," are one of several Keresan speaking groups that live in the middle Rio Grande area. Archaeological evidence supports their ancestral creation and migration stories (Strong 1979, Bayer 1994).

The Historic Period in the Southwest is initiated with the 1540 *entrada* of the Spanish. In 1598 Oñate arrived in the Rio Grande Valley, claiming the region for the King of Spain and began his colonization and subjugation efforts (Strong 1979, Bayer 1994). After years of oppression, exploitation, desecration, spiritual persecution, disease, in addition to drought and resulting famine, the Tamayame actively joined with other Rio Grande Pueblos to expel the Spaniards in what has been called the Pueblo Revolt of 1680 (Strong 1979, Simmons 1988, Bayer 1994). In the aftermath, and as a result of the effects of the Revolt and several subsequent Spanish forays in which numerous Puebloan pueblos, including those of the Santa Anan people, were attacked and burned, the Tamayame affiliated themselves with the Spaniards after de Vargas' Reconquest (Strong 1979, Bayer 1994). The Tamayame resettled in an area of traditional use, building homes and a Spanish church at Tamaya (Harrington 1916, Bayer 1994).

At the end of the Seventeenth Century, the Puebloans received grants from the Spaniards for the land around their Pueblos. However, these areas did not include all of the areas the Puebloans had traditionally used and, located in such an arid and marginal environment as that of the Southwest, were generally not large enough to sufficiently support the Pueblo. The Tamayame soon recognized that land and water would increasingly become scarce with the influx and rapid population growth of the colonizers. In order to reestablish their claims to the Ranchiit'u and other nearby areas, the Tamayame, in 1709, started purchasing the land back (White 1942, Strong 1979, Bayer 1994). Eventually, the majority of the Tamayame moved to, and today continue to live in, the Ranchiit'u area (Harrington 1916, Strong 1979, Bayer 1994). Encroachment, trespass, fraudulent claims, and schemes continually pressed the Tamayame for their land (Bayer 1994).

In 1821 Mexico won its independence from Spain and in 1846 the United States invaded and took the Southwest. Through most of the Historic Period, the Tamayame and their neighbors farmed along the streams and rivers, grazed livestock in the upland areas, and utilized regional timber resources and a few did some mining. It was not until 1869 that Congress confirmed the land claims of the Santa Anas; the patent was not issued until 1883 (White 1942, USGAO 2001). However, it was not until the *Sandoval* case was settled in 1913 that most of the land problems were abated; but not ended (White 1942, Bayer 1994).

In the 1880s, the arrival of Atchison, Topeka, and Santa Fe (AT&SF) Railroad brought a huge and rapid influx of new residents to New Mexico (Bayer 1994). The AT&SF Railroad's main line tracks were laid through Pueblo of Santa Ana's Ranchiit'u in 1880 as the line was pushed southward to Albuquerque and Belen (Bayer 1994). The construction of branch lines soon followed. The Santa Fe Northwestern Railway (SFNW) was one such branch line that, in order to reach timber resources in the Cañon de San Diego Grant and the Jemez Mountains, crossed not only the Ranchiit'u, but also the Spanish Pueblo Grant at Tamaya, and Pueblo of Santa Ana's traditional lands in the Ojo de Espiritu Santo Grant as well as the Spanish Pueblo Grants at Zia and Jemez (Glover 1990, Bayer 1994). Initial surveys for the SFNW route to the Jemez Mountains were conducted in 1921, a construction contract was awarded on October 16, 1922, and work in the roadbed in Bernalillo began on November 8, 1922 (Glover 1990). Work on the massive, wooden Rio Grande trestle was completed early in 1923 (Glover 1990). The right-of-way agreement with the Pueblos of Santa Ana, Zia, and Jemez was signed in March, 1926, was legally questioned, and was then reapproved on July 10, 1928 (Glover 1990, Bayer 1994). The SFNW ceased operations and the railroad was abandoned in 1941; today, all that remains in the Ranchiit'u area are portions of the old railroad grade bed and cut-off pieces of the old Rio Grande trestle pilings (Glover 1990).

Formation of the Middle Rio Grande Conservancy District (MRGCD) was approved in 1924 and operations began the next year to provide facilities for the efficient delivery of irrigation, domestic use and stock water, to prevent flood hazards and provide flood protection measures, to regulate the Rio Grande channel and stream flows, and to provide drains to reclaim land that had become saturated and saline from high groundwater levels (Ackerly *et al*. 1997). The development and rehabilitation work conducted by the MRGCD had impacts to the Ranchiit'u area in the form of rights-of-way for flood control structures, ditches and drains; however, these structures have also provided flood control and made irrigation of the Ranchiit'u land easier for the Tamayame (Bayer 1994). To assist in the prevention of flood hazards and providing for flood protection measures, the U.S. Army Corps of Engineers has also constructed flood protection structures on Pueblo of Santa Ana Reservation lands such as the Jemez Canyon Dam (Rodgers 1979).

<u>Cultural Resources</u>

A search of the New Mexico Historic Preservation Division's Archeological Records Management Section database was conducted to identify cultural resources sites reported within the vicinity of the project area. The database search found that no archaeological sites have been reported within the river's 100-year floodplain in the project area; and therefore, no sites are reported to occur in the vicinity of the proposed construction areas along the Rio Grande channel.

Inspection of aerial photography of the project location for the years 1935, 1952, 1963, and 1997 indicates that all of the 100-year floodplain in this area (except for a small area that will not be disturbed by the current project) has at one time or another since the 1930s been part of the river's active channel. On-site inspection and aerial photography of the project area also indicates that significant aggradation, some of which was induced by the installation of Kellner jetty-jacks, has also occurred historically in this river reach. Therefore, if cultural resources sites were within the 100-year floodplain, they would have been either washed away by the river and/or buried by significant sediment deposition.

A database search of the State Register of Cultural Properties, maintained by the NMHPD, and of the National Register of Historic Places found that numerous State and National Register properties occur within the historic community of Bernalillo as well as several that are located in the general vicinity of the project area. Of these, Coronado State Monument Museum (State Register No. 1515) and Kuaua Ruin (State Register No. 225) are located downstream of the project area. They are, however, located on gravel terraces well above the river channel.

At the southern portion of the project area are piling remnants of the Rio Grande trestle once used by the Santa Fe Northwestern Railway (SFNW). These piling remnants are only visible during low river flows. The SFNW was in operation from 1922 to 1941 and the Rio Grande trestle was constructed in early 1923 (Glover 1990, Myrick 1990). A portion of the railroad's grade bed is also visible on the west side of the river on Pueblo of Santa Ana and Coronado State Monument lands.

A levee and drain system operated by the MRGCD traverses the eastern edge of the project area. Many of the levees, drains, irrigation ditches, and associated structures and features along the middle Rio Grande were constructed in the 1930s (Ackerly *et al*. 1997, Berry and Lewis 1997) and, therefore, are considered historic. The levee and associated service road surfaces were not surveyed for cultural resources because they are built-up roads and their surfaces have been disturbed numerous times since their construction in the 1930s.

On the west side of the river, existing paved and improved gravel roads that cross upland areas of the Pueblo of Santa Ana Reservation would be utilized to access proposed construction areas. On May 17, 2001, two Corps archaeologists conducted an intensive cultural resources inventory of portions of the two west side access roads. The pedestrian survey was conducted by walking 10-meter wide linear transects along either side of the roads; a total of approximately 29.2 acres was covered. The survey found no artifacts or cultural resource manifestations.

In recent years, the Pueblo of Santa Ana has been actively working to develop and protect it's natural and cultural resources and has sponsored numerous archaeological surveys on Pueblo lands in anticipation of construction and rehabilitation projects and habitat restoration efforts related to Pueblo development. Other access and staging areas anticipated for use in this proposed Section 1135 restoration project have been previously surveyed for cultural resources and received use clearance or have been previously disturbed and utilized for similar purposes.

2.13 SOCIO-ECONOMIC ENVIRONMENT

The Pueblo of Santa Ana Reservation covers approximately 90,000 acres spanning the Rio Grande and lower Jemez River. The majority of the population of approximately 720 resides near Los Ranchitos along the east side of the Rio Grande.

Principal employment sectors at the Pueblo and throughout Sandoval County include agriculture and service. Over the past 25 years, the Pueblo of Santa Ana has developed a successful agricultural enterprise centered on the production and processing of organic blue corn products. Other natural resource enterprises include sand and gravel mining and a native plant nursery. Extensive recreational and entertainment attractions include the Santa Ana Star Casino, the Prairie Star Restaurant, a 27-hole golf course, and a 22-field soccer complex.

The 350-room, Pueblo-owned, Tamaya Hyatt Resort is located outside of the 100-year floodplain immediately to the west of the proposed project area. The resort opened in January 2001 and includes an 18-hole golf course on the terraces to the west.

2.14 LAND USE AND RECREATIONAL RESOURCES

The Rio Grande corridor in the project area has been declared a natural preserve by the Pueblo of Santa Ana Tribal Council. Ecosystem restoration activities are a primary objective of the preserve plan. Recreational opportunities along the Rio Grande within the study reach which are available to tribal member, resort guests, and invited guests of the Pueblo include hiking, horse riding, nature observation, fishing, and canoeing/kayaking.

Coronado State Monument is immediately south of the Pueblo of Santa Ana Reservation boundary. Located on the west bank of the Rio Grande, the park includes a visitor center, partially excavated pueblo ruins, and picnic area. It is managed by New Mexico State Monuments (Museum of New Mexico, Office of Cultural Affairs, State of New Mexico) and receives about 30,000 visitors annually.

2.15 HAZARDOUS, TOXIC, AND RADIOLOGICAL WASTE

No sources of hazardous, toxic, or radiological waste (HTRW) are known to occur in the project area. Pertinent portions of the project area and potential access road alignments were examined by the Corps in May 2001. Minimal residential debris was noted. No areas with potential HTRW impacts were identified during the project area walk-through. Pueblo of Santa Ana Department of Natural Resources personnel have not identified any areas of concern.

3. FUTURE CONDITIONS WITHOUT PROJECT

Future conditions without project implementation were projected to characterize the "no action" alternative and its effects, and to form a basis for comparison of restoration benefits. The following summarizes future conditions for pertinent (*i.e.*, hydrologic, geomorphic, and ecologic) resources.

3.01 HYDROLOGY AND GEOMORPHOLOGY

Corps of Engineers restoration projects often assume a 50-year project life for benefit evaluation purposes; therefore, hydraulic parameters 50 years hence were estimated given observed degradation rates in the Santa Ana reach of the Rio Grande. Hydrology was based on the average annual hydrograph at the Albuquerque gage for the post-Cochiti Dam period (1974-1999). Hydraulic conditions were based on equilibrium slope and sediment transport analyses. The equilibrium slope analysis provides an estimate of ultimate channel slope neglecting the time required to transport sediment from the reach; therefore, sediment transport was then utilized to determine the channel adjustment that could be reasonably achieved within 50 years. The equilibrium slope analysis resulted in a channel slope of 0.0006 ft/ft. To apply the equilibrium slope to a river reach, a location downstream from which to project the slope must be designated. Usually a stable control location such as near a dam, diversion structure or bedrock outcrop is used for the projection point. Lacking such a feature near the Santa Ana reach, a downstream location that would result in an amount of degradation that could realistically be transported within 50 years was selected. The location of Cochiti Rangeline CO-30, approximately 1.5 miles downstream of the Highway 550 bridge in Bernalillo, was selected as the downstream projection point for the equilibrium slope.

The degradation volume to be expected within 50 years was computed using the Modified Einstein Procedure and sediment transport rating curves developed for the supply and outflow of the Santa Ana reach. This resulted in a sediment loss rate of 42,000 tons/year. This degradation rate is somewhat less than that observed between 1975 and 1992 and is more consistent with observations between 1995 and 1999; therefore, it is felt to be a realistic yet conservative estimate.

A hydraulic model with modified cross sections representing the future channel geometry and profile was developed for the analysis. The historical and assumed future channel elevation profiles and cross sections are shown in Figures 6 and 7, respectively. In summary, the observed degradation would continue, resulting in a significantly deeper and narrower channel (Table 5). The minimum channel elevation (thalweg) would drop an additional 6 feet throughout the reach. Entrenchment essentially would eliminate slackwater overbank areas.

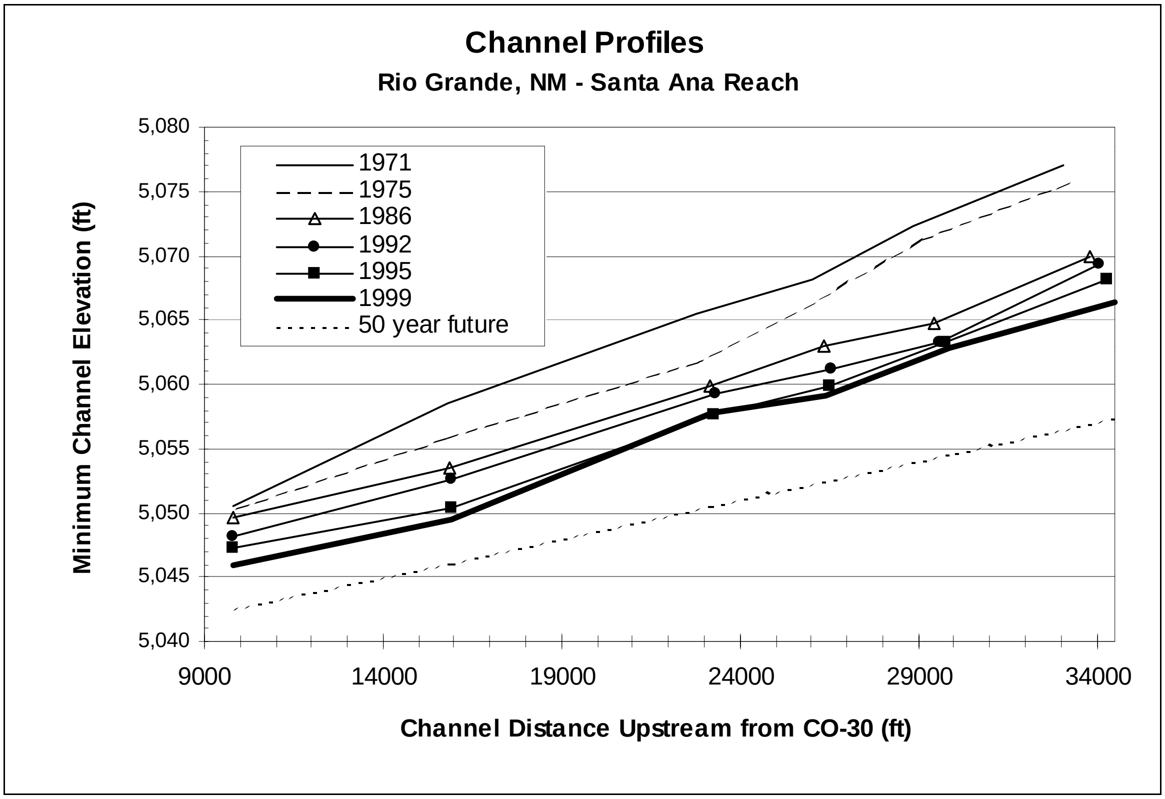

Figure 6. Historical and predicted future profiles.

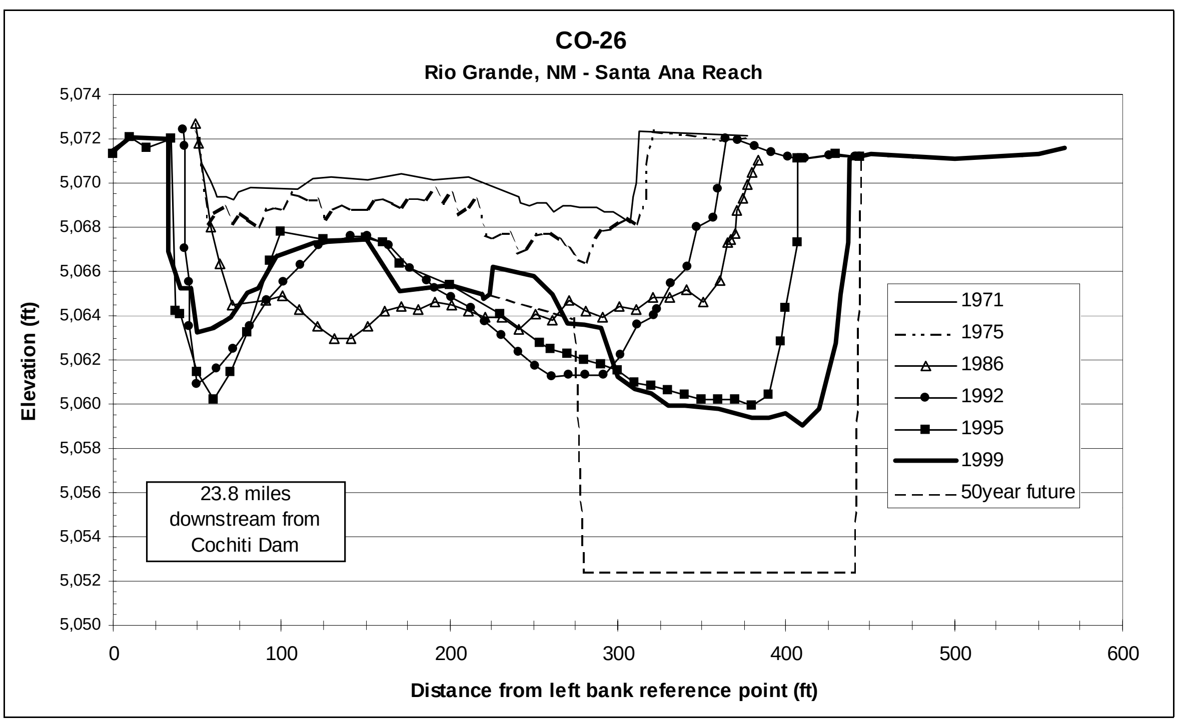

Figure 7. Historical and predicted future cross section at Cochiti Rangeline CO-26. (Elevation datum is NGVD).

Table 5. Selected existing and estimated 50-year future (without-project) hydraulic conditions at 5,400 cfs (2-year discharge) in the Santa Ana reach of the Rio Grande.

Parameter	Existing condition	Future condition (without project)
Average channel velocity (fps)	4.3	4.8
Average channel topwidth (ft)	238	170
Average channel depth (ft)	5.0	6.8
Total inundated area (acres)	125	53
Total width/depth ratio	48	25

3.02 ECOLOGICAL SETTING

Throughout the Middle Rio Grande Valley, the river, floodplain, and the associated fish and wildlife populations would be expected to continue to experience adverse effects from new and ongoing Federal, State, and private water resource development projects. Additionally, increasing urbanization and development within the historic floodplain would continue to eliminate remnant riparian areas located outside the levees, putting increased pressure on the habitat and wildlife in the riparian zone within the floodway.

The Rio Grande channel downstream from Cochiti Dam would become narrower and deeper, negatively affecting warmwater fishes and reducing native aquatic habitat. Widespread extirpation of native fish species would continue, further altering the aquatic community. The quality of river and ground water would be increasingly affected by urban discharges and agricultural runoff. The lack of flooding in the riparian zone and a lowered water table would continue to restrict opportunities for wetland formation and maintenance, causing the remaining cottonwoods to die off, and growth of non-native vegetation such as saltcedar and Russian olive to increase. The native cottonwood/willow vegetative complex gradually would be replaced with non-native species. The overall quality and quantity of fish and wildlife habitat would continue to degrade, and species that do not adapt to the changes would be stressed and eventually disappear from the system (Crawford *et al.* 1993).

In the Santa Ana reach, chronic channel degradation would continue, with a concomitant reduction in aquatic habitat area and quality. There would continue to be a lack of wetland and shallow water aquatic habitat in the project area. Channel incision would result in lowered water table levels, further contributing to degraded conditions in adjacent riparian communities. Native vegetation would continue to be replaced by non-native vegetation, as the remaining native vegetation becomes decadent and dies. Fish and wildlife in the project area would continue to follow the same decline in the project area as throughout the Middle Rio Grande valley.

Without identification and effective implementation of recovery measures for the endangered Rio Grande silvery minnow and Southwestern Willow Flycatcher, these species may become extinct in the foreseeable future. The wetted channel would continue to decrease in width and increase in depth, a situation that is detrimental to the Rio Grande silvery minnow. Suitable flycatcher habitat would continue to be absent in the project area. Mature cottonwood stands would die naturally of senescence lacking recruitment of native riparian habitat. Without adequate cottonwood regeneration, Bald Eagle perch habitat would be eliminated from the Santa Ana reach.

4. PLAN FORMULATION

4.01 PLANNING OBJECTIVES

Beginning in 1998, the Pueblo of Santa Ana facilitated several planning sessions with the U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, the Bureau of Indian Affairs, Ayres Associates, David Evans and Associates, Inc., and the Corps, to discuss the objectives of the Pueblo's overall restoration plan along the Rio Grande. Through these sessions and ensuing coordination, degraded ecosystem functions and values were identified and potential solutions were suggested.

This section summarizes plan formulation and alternative analysis activities specific to the Corps' portion of the overall plan. The initial objectives of this Section 1135 feasibility study included (in increasing order of importance):

- riparian woodland ("bosque") restoration;
- reintroduce riparian zone inundation; and
- halt degradation of the Rio Grande channel and improve geomorphic characteristics (toward the recent historic condition).

4.02 HYDRAULIC MODELING

Hydraulic modeling was performed to support problem identification and the evaluation of alternatives (and, later, design of the preferred plan). One-dimensional hydraulic modeling was performed using the HEC-RAS River Analysis System (HEC 1998) and 2-dimensional modeling was completed with the finite element model RMA-2V (WES 1998). Initial 1-dimensional modeling included six cross sections (Cochiti Rangelines) through the project area. Results from this modeling effort were used for comparative analysis of historical trends of channel geometry and hydraulic characteristics for the Santa Ana reach of the Rio Grande. Detailed 1-dimensional hydraulic modeling included approximately 60 cross sections throughout the Santa Ana reach and was used to evaluate existing conditions, sediment transport, stable channel design and preliminary design of restoration alternatives. The 2-dimensional modeling was used to verify results from the 1-dimensional modeling efforts, refine the hydraulic design, and determine restoration benefits.

4.03 BOSQUE RESTORATION

Bosque restoration efforts similar to those already accomplished by the Pueblo of Santa Ana were originally anticipated to be continued in this Section 1135 project. Methodology and costs were identified as a result of the Pueblo's previous experience, and bosque restoration activities were determined to be ecologically justified and cost effective. However, given the cost of the primary objective (halting degradation), the lower priority of bosque restoration activities, and the opportunities for support of riparian restoration projects from other agencies, this objective is not recommended for implementation under this Section 1135 project.

4.04 RIPARIAN ZONE INUNDATION

The hydraulic model analyzed the potential for the reintroduction of surface water inundation to the riparian zone adjacent to the incised Rio Grande channel. The water surface of the 20%-chance (5-year) discharge currently is approximately 4 feet below the vegetated bankline of the bosque. Riparian inundation is now expected to occur at a discharge of 15,000 cfs (2%-chance [50-year] discharge). Construction of grade control structures approximately 4-feet tall would be required to sufficiently raise the river bed to promote such inundation. While achievable, these structures would be very costly and, more importantly, would present a significant obstacle to upstream movement of native fish species, including the Rio Grande silvery minnow.

The hydraulic model also was used to determine if now-abandoned high-flow side channels were available to induce at least partial bosque inundation. No channels were identified which would accomplish this objective.

Given the constraints outlined above, and the lack of acceptable hydraulic conditions, consideration of the reintroduction of bosque inundation was eliminated from further planning consideration.

4.05 CHANNEL IMPROVEMENTS

Grade control structures consisting of sheetpiling and rip-rap have been traditionally used to stabilize channels experiencing deleterious degradation. These structures can often impede upstream movement of fish. For the current project, grade control structures which include downstream aprons to facilitate fish passage (termed "grade restoration facilities" or "GRFs") were evaluated. Based on engineering expertise and experience with these structures, two or three GRFs were anticipated to be required to stabilize the entire study reach. Briefly, the GRFs consist of sheetpiling at the upstream end with an approximately 400-foot-long apron downstream, the slope of which conforms to existing riffles in the reach. (A detailed description of structures is given in Section 5.) Height of the GRFs at their upstream end would be approximately two feet – a compromise between maintaining fish passage and increasing the bed elevation.

While the channel would be stabilized upstream from the structures, continued bed degradation would be expected immediately below the most downstream GRF. Therefore, an additional structure was included in the design to avoid an abrupt change in bed elevation. A bed sill composed of launchable gravel would be installed well downstream from the last GRF. Over time, the gravel sill would provide a transitional riffle between the stabilized and degrading portions of the channel.

4.06 INCREMENTAL COST ANALYSIS AND PLAN SELECTION

Corps of Engineer regulations require that ecosystem restoration projects be analyzed for cost-effectiveness and incremental benefits expected from contemplated restoration alternatives. Analysis of cost-effectiveness, in general, compares the relative costs and benefits of alternative plans. The least expensive plan which meets the restoration objective is usually selected. “Incremental cost analysis” is the technique used by the Corps to develop cost-effective restoration projects (Orth 1994, Robinson *et. al.* 1995). and this is particularly well suited for analysis of a series of features, each entailing successively greater benefits and costs. Incremental analysis calculates the *cost per unit of output* gained by each successive feature, allowing the planning team to determine the point of diminishing returns. The final selection of a recommended alternative also may be influenced by non-economic considerations such as, specific output targets, budget constraints, impacts to other environmental resources, and opportunity costs.

As explained in the previous section, two or three GRFs (in addition to the existing GRF #1 already built by the Bureau of Reclamation) were evaluated for construction. The hydraulically logical order of consideration for inclusion in the plan is from upstream to downstream. Therefore, the incremental cost analysis for the current project is relatively simple – a linear array of costs and ecosystem benefits gained for each successive GRF. Cost estimates for structures were based on estimated construction material quantities and were computed using Corps of Engineers M-CASES GOLD cost estimation methods.

Generally, to compare the cost effectiveness of various restoration alternatives, an environmental output unit is required. An output unit is the quantification of expected improvement in target functions or values, such as increased productivity or habitat suitability/availability. In the current study, several geomorphic characteristics are expected to improve within the study reach with the construction of GRFs relative to the existing and future without-project conditions (see Table 5). To evaluate the relative value of the individual GRF structures, the simple parameter of length of channel stabilized by each structure was selected as ecosystem output indicator. Since the downstream bed sill would also contribute to stabilization of the downstream portion of the reach it was also included in the analysis; however, the value of the indicator was halved since some degradation would be allowed within this reach.

Incremental cost analysis results are given in Table 6 and Figure 8. Three GRFs[4] are economically justified on the basis of the average cost per unit of improvement. Differences in the incremental cost per unit were largely the result the structures' locations, which were selected based on the channel's existing elevational profile.

Although three GRFs are economically justified, funding constraints limit the selected plan to the construction of two GRFs and the downstream bed sill. The location of GRF #3 may be moved downstream during the final design in order to maximize the length of stabilized channel.

[4] Numbering of the proposed GRF structures begins with "2" to avoid confusion with the existing "GRF #1" built by the Bureau of Reclamation in 2001.

Table 6. Incremental cost analysis results.

Structure	Cost per structure	Stabilized channel length (feet)	Incremental cost per unit	Cumulative cost	Cumulative stabilized channel length (feet)	Average cost per unit
GRF2	2,417,000	4,500	537	2,417,000	4,500	537
GRF3	2,489,000	2,300	1,082	4,906,000	6,800	721
GRF4	2,012,000	4,600	437	6,918,000	11,400	607
Bed Sill	780,000	1,100	709	7,698,000	12,500	616

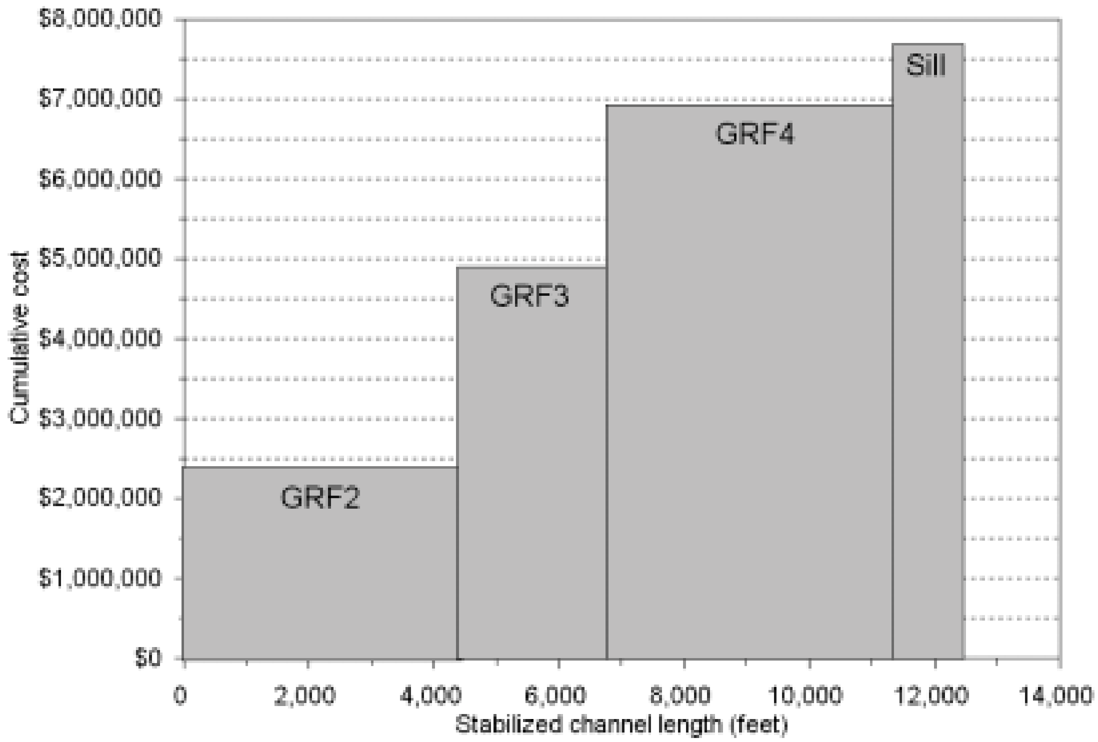

Figure 8. Cumulative cost and benefits of structures.

5. DESCRIPTIONS OF THE PROPOSED PLAN AND ALTERNATIVES

The selected plan includes grade restoration facilities (GRFs) #2 and #3, plus a downstream bed sill. Should cost-saving design improvements or construction methods result during the preparation of final plans and specifications, the additional construction of GRF#4 may become economically feasible, and, therefore, is here considered as a project alternative. The majority of the background and analyses described for GRFs #2 and #3 also apply to GRF #4. For convenience, GRF #4 is included on many plates depicting GRF #2 and #3.

Additional alternative construction methods discussed below include local *versus* commercial riprap sources; and alternative waste soil disposal sites.

(Future conditions without project implementation – that is, the "no action" alternative – has been described in Section 3.)

5.01 GRADE RESTORATION FACILITIES

GRFs #2 and #3

Two gradient restoration facilities (GRFs) and a downstream bed sill were selected for grade control considering the objectives of fish passage and channel stabilization. A GRF is a sloping rock structure that provides vertical channel stabilization while maintaining fish passage. The GRFs were designed to emulate hydraulics of natural riffles in the Santa Ana reach.

Detailed one-dimensional hydraulic modeling utilized survey data from approximately 60 cross sections within the study reach of the Rio Grande. All of the model cross sections were surveyed in August of 1999 to provide a representation of the existing conditions in the reach. As with the historical cross sections, the 1999 survey only included the channel between vegetated banklines. Riparian zone topography was added to the models for the purpose of modeling higher flow events and was developed from a 1992 digital terrain model from the U.S. Bureau of Reclamation, Albuquerque Area Office. The model was calibrated to observed discharges in the reach.

The hydraulic design objective was to stabilize and enhance the Rio Grande channel within the Pueblo of Santa Ana while satisfying a constraint of fish passage. Of primary concern was passage of the Rio Grande silvery minnow which has been classified as an endangered species. Therefore, hydraulic structures used for channel stabilization should provide appropriate depths and velocities for fish passage. Sustained swimming speeds, which vary with species and fish size, are often used in passage design; however, these data are not available for the silvery minnow due to limited physiological information on the species. Since silvery minnow are known to pass through the Santa Ana reach, hydraulic data collected by the Bureau of Reclamation at three representative riffles were used as a basis for fish passage design. A design criteria was established such that hydraulic conditions at a GRF would not present more adverse hydraulic conditions (less swimmable) than that observed at other existing riffles in the reach. Using information from the analysis of the three reference riffles, a length of 400 feet and slope of 0.005 ft/ft was selected as the design dimensions for the GRFs. This slope and length would provide a 2-foot rise in bed elevation through the structure and should result in a similar increase in water surface elevation at low flow conditions.

The design of the GRF cross section also utilized information from the existing reference riffles. Cross sections from the riffles were used to develop a section template for the GRFs. The three reference riffle cross sections were aligned, normalized in elevation, and their dimensions were averaged to provide a composite cross section used as a template for the GRF section at each structure location.

The siting of GRF structures was determined using the existing river planform and profile as a guide. In channels such as the Santa Ana reach of the Rio Grande it is hydraulically advantageous to superimpose grade control at existing riffles or breakpoints in the channel profile. This approach involves placing the upstream end of a GRF on a natural high point in the profile. By superimposing a GRF on an existing breakpoint, less material would be required to achieve a target elevation and the backwater effect created by the structure will have a greater length of influence upstream. The proposed locations for GRFs #2 and #3 are approximately 1,000 feet and 3,400 feet, respectively, downstream from rangeline CO-27 (Plate D.1).

The GRFs include several structural components (detailed below): sheetpile/cutoff wall, main channel apron, overbank armor, upstream and downstream channel transitions, upstream and downstream overbank cap, and bankline revetment keys.

Steel (or equivalent) sheetpiling would be installed along the upstream crest of each GRF and extend laterally into the vegetated banks. For protection against scour, the sheetpiling would extend to a depth of 10 feet below the design grade in the channel and 8.5 feet below design grade in the overbanks. The upper edge of the sheetpiling would define the new channel cross-section – lowest in the channel center and gradually rising toward the banks – and would be at least 6 inches below the grade through the overbank areas. At the lowest portion of the channel, the height of the sheetpiling above existing grade would be approximately 2 feet.

The GRF main channel apron is the primary component that would provide grade control for the river channel. The apron would extend downstream from the sheetpiling and would increase bed elevation, increase roughness through the design riffle, and reduce sediment transport in the upstream reach. The combined effects of the GRFs applied in series are intended to halt the degradation trend in the lower Santa Ana reach.

General design dimensions of the main channel apron of the GRFs include length in the flow direction, slope, and channel section (width). The length of each structure (not including upstream and downstream transitions) would be 400 feet with a slope of 0.005 ft/ft. The width of each structure is dependent on the existing channel section and would be approximately 320 and 200 feet for GRF#2 and #3, respectively. GRF#2 would be located at a split flow location (see Plate 1) and the eastern channel would be graded and armored similar to the main channel apron.

The GRF apron would be constructed of 12-inch-diameter riprap placed in a 2-foot-thick layer across the channel. Riprap sizes were selected for the main channel and overbank areas that would be sufficient for all GRFs rather than specifying different rock sizes for each structure. Construction of the main channel apron will require excavation and grading of the existing channel section prior to rock placement. The riprap was designed to remain stable during the 1%-chance (100-year) flood event. Plan views of the GRFs with proposed contours are shown on Plates 2 and 3. Design cross sections and thalweg profiles are shown on Plates 5, 6, and 8.

A transitional layer of granular filter material would underlay the riprap used in the GRF components with the exception of the overbank caps. The filter would prevent the migration of fine material through voids in the riprap and would relieve hydrostatic pressure within the subgrade for varying water levels. A 6-inch thick layer of nominal 1-inch-diameter gravel would underlay both the main channel and overbank areas.

The sheetpile cutoff walls would extend into the vegetated bankline and are intended to prevent flanking and to secure the design grade across the full width of the river channel. Based on a project life of 50 years and the observed potential for bank migration within the project reach, the sheetpile cutoff walls would extend 150 feet beyond the cut bank at each GRF. The cutoff wall would be angled upstream on the cut bank to direct flow towards the main channel if significant bank erosion is experienced. On the opposite side of the channel the sheetpiling should extend into the bank 100 feet. Plan, elevation and profile diagrams of the sheetpile cutoff walls are shown on Plates 2 through 6.

The upstream and downstream channel transitions would provide a gradual progression from the GRF to the adjacent channel elevation. The transitions should reduce the potential for excessive hydraulic forces at the intersection of the GRF and the existing channel. The transition would be constructed on a 20H:1V (0.05 ft/ft) slope and extend into the channel bed to a depth sufficient to provide scour protection. The transitions were designed to extend into the streambed 6 feet below the GRF crest and downstream termination point. Launchable riprap end sections were designed to provide an additional 2 feet of scour protection. This should provide armoring to a depth of 8 feet below the upstream and downstream GRF apron elevations. Profiles of the upstream and downstream channel transition are illustrated on Plate 8.

The overbank armor would provide stability within the overbank areas during high flow events. The armor is intended to prevent scour in the overbank area between the upstream and downstream limits of the structures. The overbank armor would consist of a 1-foot layer of 6-inch-diameter riprap, underlain by a 0.5-foot-thick, 1-inch-diameter gravel filter. Placement of the overbank armor will require 2 feet of excavation below the design grade and for aesthetic purposes the riprap will be backfilled with 0.5 foot of native soil material. Profiles of the overbank armor are illustrated on Plate 9.

The upstream and downstream overbank caps would provide protection against flanking and undermining at the upstream and downstream limits of the GRFs in the overbank areas. The overbank cap would also help stabilize the sheetpile cutoff wall at the upstream end of each structure. The overbank caps are to be constructed by excavating a 4.5-foot-deep trench through the overbank at the upstream and downstream limits of the GRF apron. The trench would extend from the bankline to the bosque vegetation line. The trench will be backfilled with 6-inch-diameter riprap to within 0.5 foot of the design grade and the remainder backfilled with native material to preserve aesthetics in the overbank areas. A plan view of the overbanks caps are shown on Plates 2 and 3. Design sections of the overbank caps are illustrated on Plates 4 and 5 and profiles are illustrated on Plate 9.

Bankline revetment keys will provide bank protection upstream and downstream of the GRFs. The keys would extend approximately 100 feet upstream and downstream of the GRF apron and curve into the overbank at a constructed radius of approximately 50 feet. The bankline key would extend into the overbank approximately 50 feet. Construction of the keys will require excavation along the bankline and excavation into the overbank along the curve. The keys would be constructed with a layer of 12-inch-diameter riprap underlain by a 0.5 foot layer of 1-inch-diameter gravel. The bankline revetment would include a launchable toe section to provide scour protection. A scour depth of 8 feet was considered in design of the launchable toe. Plan views of the bankline revetment keys are shown on Plates 2 and 3. Design sections of the revetment are illustrated on Plate 10.

<u>GRF #4</u>

GRF#4 would be located approximately 1,000 feet downstream from GRF #3 and 1,000 feet downstream from rangeline CO-28. The width of GRF #4 would be approximately 270 feet. Details are shown in Plates 4, 7, and 8.

5.02 BED SILL

A bed sill was designed to provide grade control at the downstream end of the project reach. The sill would be located at the most downstream location where Pueblo of Santa Ana Reservation lands occupy both banks (approximately 4,000 feet downstream from rangeline CO-28). The bed sill would consist of a trench excavated across the streambed and then filled with rock. The rock-filled trench would contain a sufficient volume of material to launch into the channel and provide an armoring layer as the downstream channel continues to degrade. It is desired that the armor launch at a slope that is passable to native fish. The ultimate slope of the sill would be affected by the size of rock used, the frequency and magnitude of flow, and the rate of downstream channel degradation.

It is assumed that peak flow hydraulics would act to distribute the armor material as the downstream channel degrades. Smaller rock sizes would be distributed over a longer distance and launch and at a flatter slope than larger rock. Material that would be stable at its natural angle of repose under the peak flow hydraulic conditions would likely launch at a slope similar to the repose angle. The natural angle of repose for granular material less than 1 foot in size is on the order of 40 degrees. This corresponds to a slope of 0.8 ft/ft which is significantly steeper than the channel slopes observed for the natural riffles in Santa Ana reach as previously described. The natural riffle analysis identified slopes assumed to be passable to fishes. Therefore the bed sill design selected rock sizes that would launch at a slope similar to the GRF design slope (0.005 ft/ft). Plan, profile and elevation diagrams of the downstream bed sill are shown on Plates 11 and 12. The bed sill configuration as installed and the desired ultimate configuration is illustrated in the channel profile on Plate 12.

The volume of rock required for the bed sill would be sufficient to provide an adequate armor layer for the designated depth of degradation. The future conditions analysis indicated that 6 feet of additional degradation could be expected within the Santa Ana reach over the next 50 years. This amount of degradation is an average for the entire reach, but at the location of the bed sill a value of 3 to 4 feet of degradation could be expected within 50 years. Considering the uncertainties in predicting the ultimate launch slope, future degradation, and recognizing that maintenance will be required for the bed sill, a degradation value of 2 feet was selected for the design. This corresponds to approximately 33 years of degradation at the bed sill location. The ultimate thickness (launched configuration) of the armor layer was designated to be 0.75 foot. This should be sufficient to develop an armor layer at the bed sill location. Therefore the volume of rock designated for the bed sill would be sufficient to launch into the downstream channel at a 0.005 ft/ft slope, develop a 0.75-foot layer thickness and provide protection for 2 feet of degradation. The actual volume of material provided in the bed sill design is based on a 1.0-foot-thick armor layer for conservativeness.

Recently, during measurement of cross sections in the Santa Ana reach, the Bureau of Reclamation encountered bedrock material along the channel bottom near the proposed location of the bed sill. During this project's final design phase, the nature of the substrate will be determined at this location and the design of the bed sill would be modified if required.

5.03 QUANTITIES

Estimates of quantities for the in-channel structures resulting from the two-dimensional hydraulic model and design analysis were computed and are given in Table 7. The construction quantities were based on bathymetric data as of August 1999.

Table 7. Construction quantities for GRFs #2 and #3, and bed sill.

Structure	Clearing/ grubbing (acre)	Overbank excavation (cu. yd.)	Channel excavation (cu. yd.)	Overbank backfill (cu. yd.)	Channel backfill (cu. yd.)	12-inch riprap (cu. yd.)	6-inch riprap (cu. yd.)	1- & 2-inch gravel (cu. yd.)	Sheetpile (sq. ft.)
GRF#2	3.4	12,993	19,416	4,820	2,549	16,989	4,831	5,720	7,660
GRF#3	3.2	13,813	19,328	5,060	829	18,819	4,926	6,014	7,600
Bed sill	2.3	1,764	6,174	n/a	n/a	n/a	n/a	7,938	n/a
Total	8.9	28,570	44,918	9,880	3,378	35,808	9,757	19,717	15,260

After allowing for expansion of excavated soil material, construction of GRFs #2, #3, and the bed sill would result in approximately 63,700 cubic yards (39.5 acre-feet) of excess ("waste") material. Excavated material to be later used as backfill would be temporarily stored on the bank adjacent to the work area or at the staging area.

Similarly, construction of GRF #4 would entail an additional 23,500 cu. yd. (14.6 acre-feet) of waste material (Table 8). The total waste material from construction of all three GRFs and the bed sill would be approximately 87,300 cu. yd (54.1 acre-feet).

Table 8. Additional construction quantities for GRF #4.

Structure	Clearing/ grubbing (acre)	Overbank excavation (cu. yd.)	Channel excavation (cu. yd.)	Overbank backfill (cu. yd.)	Channel backfill (cu. yd.)	12-inch riprap (cu. yd.)	6-inch riprap (cu. yd.)	1- & 2- inch gravel (cu. yd.)	Sheetpile (sq. ft.)
GRF#4	3.4	12,920	15,705	4,337	1,758	14,004	5,170	5,143	6,960
Total when combined with GRF#2, GRF#3, & bed sill:									
	12.3	41,490	60,623	14,217	5,136	49,812	14,927	24,815	22,220

5.04 SOURCE OF ROCK

Two sources of 6-inch and 12-inch diameter riprap were considered. Rock could be purchased from a commercial source, where it would be crushed then trucked to the work site, and temporarily stockpiled at the staging area.

Alternatively, rock could be extracted from an existing basalt quarry located near Jemez Canyon Dam, approximately 3 miles from the construction site, and which was previously used for riprap associated with dam modifications. Rock would be extracted with explosive charges, then crushed and stockpiled at the quarry site. Blasting would be required only once or twice per week during extraction.

The preferred option would be to extract riprap from the Jemez Canyon Dam quarry. This represents a cost savings of approximately $750,000 over obtaining it from a commercial source.

All 1- and 2-inch diameter gravel would be obtained from a commercial source.

5.05 SCHEDULING OF CONSTRUCTION

Construction activities relative to the installation of the GRFs and bed sill would occur within the period July 2002 through March 2003 when flows are lowest (approximately 200 – 1,400 cfs) in the Rio Grande. Preparation of access roads could occur prior to July 2002, well in advance of the start of construction.

During construction, work may be temporarily suspended for Pueblo ceremonies or special functions. Temporary work suspensions would be coordinated through all appropriate project points-of-contact.

5.06 DEWATERING, EXCAVATION AND WASTE SOIL DISPOSAL

A temporary coffer dam aligned along the center of the channel would be used to divert flows to one side of the river channel at each GRF structure during construction. Coffers may be earthen material, or consist of a steel framework covered with geotextile fabric. Pumps would be utilized to keep the work area dry. After completion of half of the GRF structure, coffers would be realigned to direct flow to the opposite side of the channel.

Soil material excavated from the footprint of each GRF structure would be deposited in the dry riverbed immediately upstream from the structure and protected by the coffer dam. Because the GRFs effectively raise the bed elevation by approximately two feet at their upstream end, the area upstream of the structure represents a prism that would eventually be filled to the new bed elevation by incoming sediment. Rather than wait for this sediment to fill in the channel, excavated material from construction would be directly deposited in the area. Spring runoff in 2003, immediately following the completion of construction, would facilitate leveling deposited sediment to conform to the post-project channel cross-section.

An upland waste soil disposal area of approximately 5 acres would accommodate the disposal of grubbed material from bars bordering the GRFs and for excavated soil in excess of the volume which can be accommodated by the channel. The final location of the disposal area would be coordinated with the Pueblo of Santa Ana and would not contain any significant ecological or cultural resources.

5.07 ACCESS AND STAGING

Access, staging, and waste disposal areas were determined through coordination with the Pueblo of Santa Ana to facilitate construction activities yet minimize traffic congestion and disturbance to residents and visitors. Access to the GRFs and bed sill would be required from both the east and west banks of the Rio Grande.

<u>West side of Rio Grande</u>

Access to GRFs #2 and #3 would be as follows: From Jemez Dam Road, all traffic would utilize an existing dirt access road (at the northern end of the project area) which is, at least partially, within a gasline right-of-way. Because the road was recently improved by the Bureau of Reclamation, no further improvement would be required. At approximately 2.6 miles from Jemez Dam Road, access to the south would be along an existing two-track dirt road paralleling, and lying outside of, the west edge of the bosque. The approximate 1.3 miles of this road would be improved to accommodate construction traffic by the addition of sand-and-gravel fill and widening to up to 30 feet. This improved section would terminate at the proposed project staging area.

A temporary, one-acre staging area for construction equipment and vehicles would be located in an already cleared area of the riparian zone between GRFs #2 and #3. Approximately 500 feet of screening material/fencing would be installed to screen the view of the staging area from the nearby Hyatt Tamaya Resort. The staging area would be enclosed by a temporary chain-link fence. Following completion of construction, the soil surface of the staging area would be scarified and planted with native grasses, forbs, and trees.

From the staging area, travel lanes would extend to the north (approximately 400 feet) to GRF#2 and to the south (approximately 500 feet) to access GRF#3. Along with the staging area, these two lanes would be revegetated following construction (except for a desired dirt road access to structures for future operation and maintenance).

Access to the bed sill location from west side of the Rio Grande would be as follows: From Jemez Dam Road, all traffic would approach the project area along a short stretch of the existing, paved Juniper Hills Road to an existing dirt road trending to the east for approximately 2,500 feet along and crossing an unnamed arroyo. This dirt road would be scraped and widened to 24 feet to accommodate traffic. Traffic would continue eastward along the paved Hyatt Tamaya Resort service road for approximately 570 feet, then follow an existing dirt road eastward for approximately 800 feet. This dirt road also would be scraped and widened to 30 feet. From that point, access to the south would be along an existing dirt track for approximately 1,700 feet. From this point near the west edge of the bosque, a new road would be cleared for approximately 1,200 feet to reach the bed sill. Both segments would be 24 to 30 feet wide.

(Access to GRF #4, should it be constructed, would only require the widening of 800 feet of an existing dirt road on the west bank of the Rio Grande.)

East side of Rio Grande

From Highway 550, traffic would gain access to all eastside construction areas by way of the existing Middle Rio Grande Conservancy District easement along the Bernalillo Riverside Drain. Traffic would travel on the levee crown and banquette (*i.e.*, two one-way lanes) for up to 1.8 miles north of the highway. The levee crown and banquette would be scraped and fill would be added as necessary.

Three access roads from the levee to the proposed structures would be created. Roads would 30-feet wide and their approximate lengths would be 415 feet to the bed sill, 200 feet to GRF#3, and 520 feet to GRF#2.

(Access to GRF #4, should it be constructed, would only require the creation of a 775-foot-long, 30-foot wide road from the levee to the east bank of the river.)

5.08 MONITORING AND ADAPTIVE MANAGEMENT

Because of the relatively recent emergence of restoration science and inherent uncertainty in ecosystem restoration theory, planning, and methods, success can vary due to a variety of technical and site-specific factors. Recognizing this uncertainty, it is prudent to allow for contingencies to address potential problems in meeting restoration goals which may arise during, or after, project implementation. Corps guidance recommends the inclusion of "adaptive management" techniques in projects with the potential for uncertainty in achieving restoration objectives. Post-project monitoring is a crucial requisite of the adaptive management process since performance feedback may generate new insights on ecosystem response and provides a basis for determining the necessity or feasibility of subsequent design or operational modifications. Success should be based on a comparison of post-project conditions to the restoration project objective(s).

Monitoring of project performance and success would be conducted annually for four years following construction / vegetative planting. Following are pertinent aspects of the monitoring plan.

Inspection of the GRFs and downstream bed sill would be conducted immediately following completion of construction to ensure that the project was built to the design specifications. This would include a topographic and bathymetric survey in the lower Santa Ana reach utilizing established rangelines. Additional cross sections (up to 5 per structure) would be established at the GRFs and bed sill location to provide more detail. Thereafter, cross sections would be measured annually for four years following construction. Annual visual inspections of structures during low flow periods, and *ad hoc* inspections following high discharge events, would also be performed.

The bed sill would require monitoring to ensure that it does not become a blockage to fishes and maintains the bed elevation at the upstream end of the sill. If the sill becomes a blockage or if degradation is in excess of the anticipated amounts, then regrading or placing additional material would be required.

5.09 REAL ESTATE REQUIREMENTS

The Pueblo of Santa Ana would provide all lands, easements, rights-of-way, relocations, and waste material disposal areas (LERRD) necessary for the project's construction, operation, and maintenance. Permanent easements total 38.5 acres and include the footprints of structures, the upland waste soil disposal area, and roads required for access. LERRD value for permanent easements is approximately $504,000. Temporary construction access accounts for an additional $78,000 of LERRD value.

(Additional LERRD values for GRF #4, if constructed, are $138,000 for permanent easements [footprint and access].)

No relocation of utilities or public facilities would be required for project implementation, operation, or maintenance.

5.10 PROJECT COSTS

The feasibility level cost estimate summary is included in Appendix C. Table 9 outlines current and future project costs.

Table 9. Project costs itemized by phase and feature.

Phase or feature	Cost by feature	Cost by phase
Feasibility Study		375,000
Plans and Specifications		250,000
Implementation[a]		
Construction contract	4,915,000	
LERRD	582,000	
Supervision and administration (6%)	394,000	
Monitoring	150,000	
Total implementation costs		6,041,000
Total Project Cost		6,666,000

[a] Implementation costs are based on 2001 dollars and include a contingency of 20 to 25% depending on the feature or activity.

This feasibility study was accomplished with Federal funding. The Total Project Cost includes the feasibility, plans and specifications, and implementation phases and is subject to cost-sharing as specified in Section 5.10.

5.11 COST SHARING REQUIREMENTS

The Pueblo of Santa Ana requested the current study and would serve as the local cost-sharing Sponsor for the project. The cost-sharing requirements and provisions would be formalized with the signing of a Project Cooperation Agreement (PCA) between the Pueblo and the Department of the Army following approval of this Detailed Project Report/Environmental Assessment. In the PCA, the Sponsor would agree to pay 25% of the total project cost which includes the feasibility study, plans and specifications phase, and implementation (construction). A draft PCA will be submitted with this Detailed Project Report for Corps Division review and eventual approval by the Federal Government and the Pueblo.

The basic criterion for non-Federal cost-sharing responsibilities for Section 1135 projects is to provide 25 percent of total project costs, as further specified below:

> Unless assumed by Federal Government, provide all lands, easements, and rights-of-way, including those necessary for borrow and dredged or excavated material disposal, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation and maintenance of the Project.

Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the Project and any Project-related betterments, except for damages due to the fault or negligence of the United States or its contractors.

Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the Project to the extent and in such detail as will properly reflect total project costs and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 33 CFR 33.20.

Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army."

Based on the above cost sharing requirements, the total project cost and pertinent cost sharing information for the proposed restoration project is displayed in Table 10.

Table 10. Cost-sharing responsibilities and requirements (October 2001 dollars).

Phase / item	Total cost	Federal expenditure	Non-Federal share
Feasibility study	375,000	375,000	0[a]
Plans and Specifications	250,000	175,000	75,000[b]
Implementation phase:			
LERRD	582,000	0	582,000
Relocations	0	0	0
Work-in-kind	35,000	0	35,000[b]
Construction & management	5,274,000	4,300,000	974,000
Monitoring	150,000	150,000	0
Total	6,666,000	5,000,000	1,666,000
Percentage	100%	75%	25%

[a] Feasibility study is initially Federally funded and is subject to cost sharing.
[b] Work-in-kind. (Amount of work-in-kind is subject to change in final PCA.)

5.12 FINANCIAL ANALYSIS

The Pueblo of Santa Ana has funds available for implementation of the project. The Pueblo has transmitted a Letter of Intent to cost share the total project cost (Appendix B).

5.13 PROJECT IMPLEMENTATION PROCEDURES AND SCHEDULE

Remaining actions necessary for the approval and implementation of this project are summarized below.

The final Detailed Project Report and the draft PCA will be transmitted to the Division Engineer, South Pacific Division, Corps of Engineers, for approval.

The PCA will be signed by the Pueblo of Santa Ana and the Federal Government.

The Corps of Engineers and the Pueblo of Santa Ana will complete the final project design and the construction contract specifications.

The Corps of Engineers and the Pueblo of Santa Ana will conduct pre-award activities. These activities will include issuing plans and specifications to interested contractors, soliciting construction bids, review of submitted bids, obtaining required Clean Water Act permits and certification, and so on.

A contract will be awarded to build the project.

PCA execution and the initiation of the Plans and Specification phase is anticipated to begin in March 2002. The construction contract is expected to be awarded in August 2002, and construction activities would take place within the August 2002 through March 2003 period. Monitoring would continue for four years following construction.

5.14 CONSISTENCY WITH PROJECT PURPOSE

The construction and operation of the proposed Section 1135 project would be consistent with the authorized purposes and current operation of Jemez Canyon and Cochiti Dams. Additionally, the proposed project would not alter the extent or frequency of damaging discharges within or downstream from the project reach.

5.15 OPERATION AND MAINTENANCE CONSIDERATIONS

Currently, the annual costs for operation, maintenance, repair, replacement and rehabilitation (OMRR&R) are estimated to be $5,000. This value includes project inspection (at least once yearly).

For most Corps of Engineers civil works projects, the responsibility for OMRR&R is assumed by the local Sponsor following construction of the project. Upon completion of construction, the Corps of Engineers will complete an Operations and Maintenance manual for the project that will summarize all OMRR&R requirements.

In order to protect the GRFs and bed sill from excessive erosion, periodic inspection and maintenance will be required. Although the design includes provisions to protect against scour and flanking, monitoring should identify potential problems or failures.

The riprap used to construct the GRFs should be monitored regularly for internal slope failures or displacement. Visual inspections should be conducted on an annual basis during low flow periods (winter months) and following high discharge events. Visual inspection in combination with survey will help identify maintenance requirements.

It is possible that floating debris, including woody material and snags, may accumulate in or around the GRFs over time. If debris is found to be causing local scour or structural damage to the GRFs, then it should be removed from the structures.

The gravel armor used to construct the downstream bed sill should be inspected regularly. Hydrographic survey and bed material sampling will be required to ensure that the sill is being displaced properly and providing a gradient that is passable to native fishes. The gradient of the streambed and water surface profile should be inspected to ensure that the structure does not exceed fish passage requirements. The sill should also be inspected to ensure that the streambed elevation along the upstream limit of the structure is not degrading. If the bed sill is determined to constitute a blockage to fish, grading of the channel bed to a milder slope will be required. If the upstream limit of the bed sill decreases in elevation by more than 0.5 foot, additional gravel should be placed to bring the stream bed back to its original design elevation.

6. FORESEEABLE EFFECTS OF THE PROPOSED PLAN

6.01 GEOMORPHOLOGY, HYDROLOGY, AND AQUATIC HABITAT

With respect to historic river geomorphology and aquatic habitat in the Middle Rio Grande, slower velocities and shallower depths are more desirable conditions for most native fish species. The objective of the proposed plan is to prevent further channel degradation in the Santa Ana reach and maintain or improve current geomorphic and aquatic habitat characteristics to the degree possible given the existing, regulated flow regime. Table 11 lists existing, future without-project (50 years hence), and proposed (GRFs) hydraulic conditions within the bankfull channel. (These reach-averaged parameters would be similar for the channel upstream from two or all three GRFs.) Because the GRFs were designed to maintain fish passage, their installation would result in relatively small changes to the existing geomorphic conditions; however, the long-term benefits compared to the future without-project condition are significant. GRFs would maintain an appreciably wider and shallower channel with lower mean velocities over the range of discharges up to 7,000 cfs (Figure 9).

Table 11. Channel hydraulic variables and percent difference compared to the future without-project ("no action") condition at 5,400 cfs (2-year discharge).

	Channel topwidth		Channel velocity		Channel depth		Channel width/ depth ratio	
	(ft)	% diff.	(fps)	% diff.	(ft)	% diff.		% diff.
Existing conditions	239	40.8	4.3	-9.0	5.0	-25.6	48.0	89.2
Future without-project	170	0.0	4.8	0.0	6.7	0.0	25.4	0.0
With project (GRFs)	241	41.9	4.0	-15.6	5.3	-21.0	45.6	79.7

Hydraulic changes in overbank areas (high-flow side channels and point bars) would provide additional preferable aquatic habitat following the installation of GRFs (Table 12). The area of overbank inundation would increase moderately compared to existing conditions. Because the expected future condition is a deep and narrow channel with little appreciable overbank areas, construction of GRFs represents a significant improvement in geomorphic and habitat characteristics. (Additional discussion of aquatic habitat improvement is contained in Section 6.06.)

Table 12. Overbank hydraulic characteristics at 5,400 cfs (2-year discharge).

	% Discharge in overbank	Overbank topwidth (ft)	Overbank depth (ft)
Existing conditions	4.7	104	1.3
Future without-project	0.0	0	0.0
With project (GRFs)	5.5	143	1.2

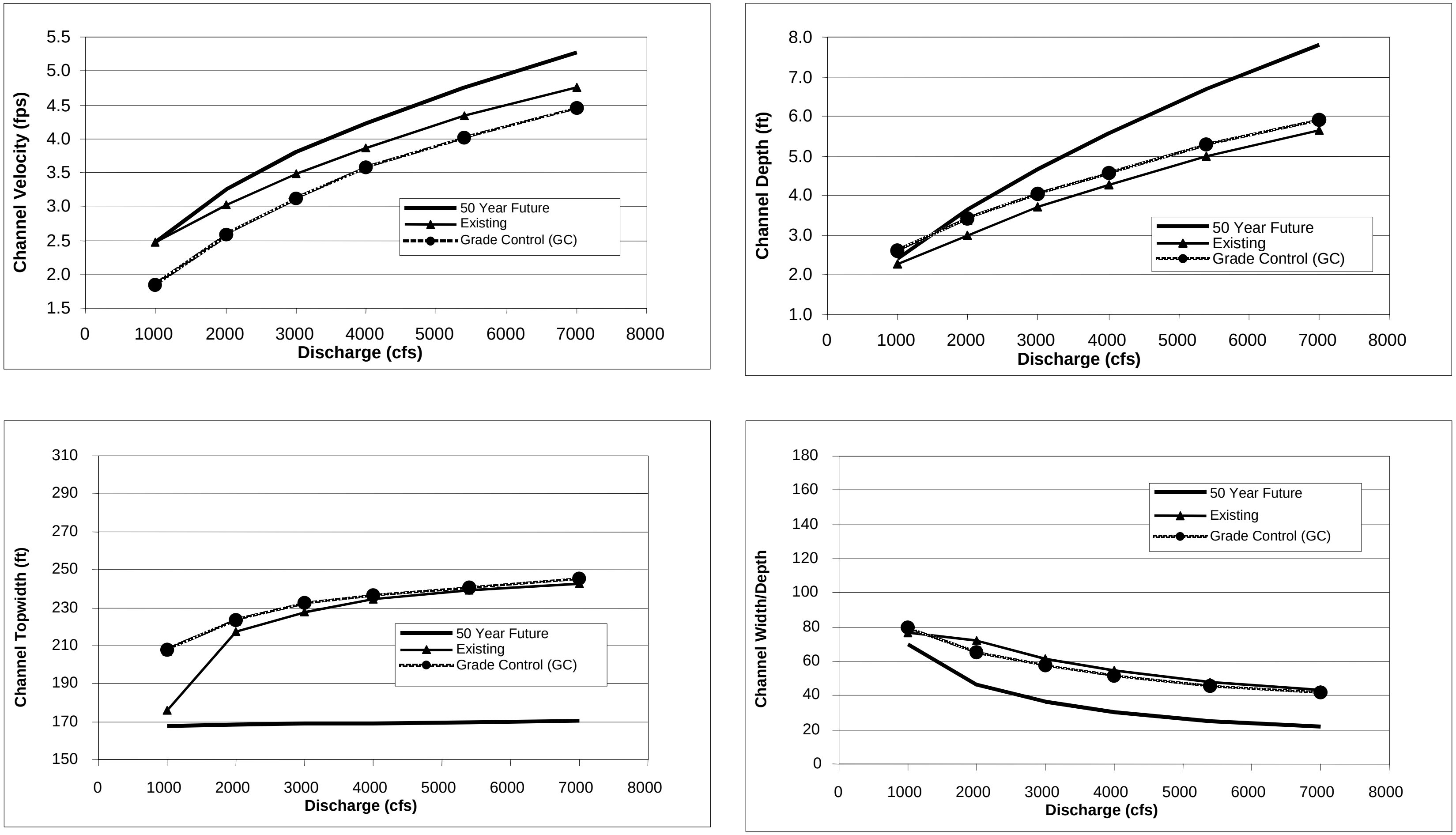

Figure 9. Channel hydraulic variables at discharges from 1,000 to 7,000 cfs. ["50 Year Future" refers to the without-project condition; "Grade Control" refers to the with-project (GRFs) condition.]

Model results indicate that the increase in water surface elevation resulting from the GRF configuration could be as much as 1.5 feet at low flows and diminishes with increasing discharge (Figure 10). Hydraulics upstream of the GRFs result in decreased energy slope, increased flow depth, and decreased velocity. The combination of these effects reduces sediment transport and may promote aggradation upstream of the structure.

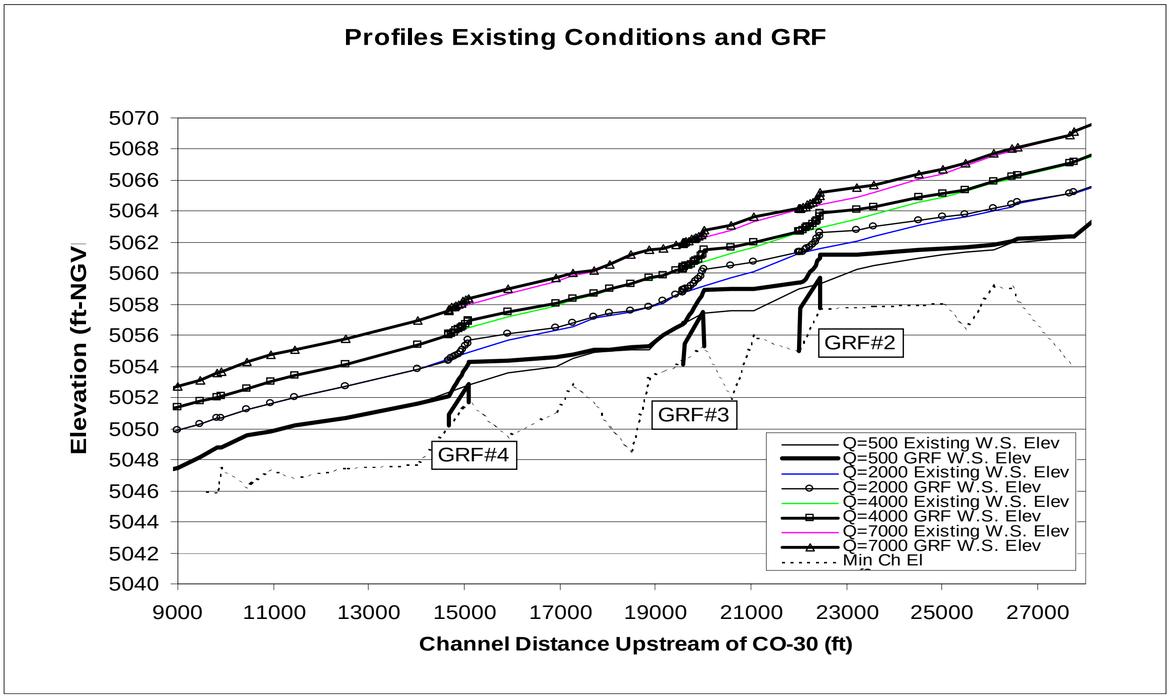

Figure 10. Comparison water surface profiles of existing and proposed conditions. (Elevation datum is NGVD).

Because the expected change in water surface elevations is small and it decreases with increasing discharge, the proposed plan would not result in increased erosion of the existing east-bank levee. Floodplain inundation above the approximate 10%-chance (10-year) event would not be altered by the installation of GRFs; therefore, the risk of flood damage during higher discharge events would not increase.

The proposed plan would stabilize the channel upstream of the GRFs; however, it would neither correct nor increase long-term degradation expected in the Rio Grande <u>downstream</u> from the Santa Ana reach. Without grade controls or additional input of sediment, the future condition of this portion of the Rio Grande is continued degradation to an eventual equilibrium slope controlled by the Isleta Diversion Dam (about 35 miles downstream from the Santa Ana reach). The future-without-project bed elevation estimated in this study (see Section 3) approximates this condition. The inclusion of the launchable gravel bed sill (with future maintenance) in the plan is intended to minimize the adverse slope which will result from continued downstream degradation.

Without grade control, the Santa Ana reach would continue to degrade, contributing approximately 42,000 tons of sediment annually to downstream areas. Following installation of GRFs, channel degradation would be arrested in the Santa Ana reach. In a study of sediment supply and transport within the Rio Grande, Diniz et al. (1995) estimated that the average annual sediment volume passing the Albuquerque gage was 1,125 acre-feet per year, or about 2,431,000 tons per year (Diniz *et al*. 1995). Therefore, the sediment withheld after construction of GRFs at Santa Ana represents only 1.7 percent of the tonnage at Albuquerque. The effect of the proposed project on the downstream sediment regime would be minimal.

The hydraulic changes resulting from the proposed project would not adversely effect the Highway 550 bridge downstream of the Santa Ana reach. The bridge is founded on pedestal piers with pilings embedded in excess of 30 feet. Although there is a potential for contraction and local scour at the bridge during high flow events, the proposed plan will not exacerbate the problem. Lateral instability would not exceed historical observations. The New Mexico State Highway and Transportation Department should anticipate long-term degradation at the bridge and continue to monitor the bridge on its biennial inspection cycle.

6.02 SOILS AND UPLAND DISPOSAL OF WASTE SOIL

Approximately 63,700 cubic yards (CY) of excess soil ("waste") would be generated from construction of GRFs #2 and #3, and the bed sill in the recommended plan. Up to approximately 37,000 CY, especially that mixed with woody plant material during initial site grubbing, would be hauled up to 3 miles from the Rio Grande and disposed on Pueblo of Santa Ana Reservation land. The area required for disposal would range from 3 to 5 acres. Several former borrow or waste areas are available for deposition of waste soils and the exact location of the deposition site(s) would be determined during the project's design phase. The waste deposition site(s) would be located only in upland areas devoid of cultural resources, endangered and threatened species, or significant ecological resources.

(Construction of GRF #4 would generate approximately 23,500 CY of waste soil, of which up to 10,000 CY would be deposited in a suitable upland area.)

A portion of the excavated soil to be used later in construction as backfill material may be temporarily stockpiled at the designated staging area.

Waste soil material not deposited in upland areas would be used to fill the channel area upstream from the GRFs, and is discussed in the following section.

6.03 WATER QUALITY AND WATERS OF THE U.S.

Installation of structures would occur between August 2002 and March 2003. Rio Grande discharge is normally lowest during this portion of the year (see Figure 1). At each structure, coffer dams placed near the channel centerline would divert flow to one side of the channel to facilitate construction of half of the structure at a time. Coffers would consist of on-site earthen material or steel frames covered with geotextile fabric, and would be installed and removed following best management guidelines. Pumps would be utilized to keep the active work area dry.

Coffers would extend at least 500 feet upstream from each GRF. Excavated waste soil would be deposited within this dry area to fill the upstream space created by the bed elevation rise of the GRF, and, following reintroduction of flow, would provide sediment to fill the voids within the GRFs' riprap aprons. A total of about 26,700 CY of material would be placed within dry portions of the channel during construction of GRFs #2 and #3. (Construction of GRF #4 would entail deposition of an additional 13,500 CY.)

The initial reintroduction of flow to previously coffered areas would increase turbidity slightly immediately downstream from the GRFs. Bed material within the channel is primarily coarse sand and gravel with only a small percentage of suspendable fine particles; therefore, increased turbidity should extend no more than one mile downstream from a structure. The temporary elevated turbidity would be similar to levels occurring annually in the Rio Grande during the spring runoff period and would not pose a threat to aquatic life.

Construction of the GRFs and downstream bed sill entails the placement of fill in areas classified as Waters of the United States under Section 404 of the Clean Water Act. An individual Section 404 permit would be obtained from the Regulatory Branch of the Albuquerque District prior to the start of construction activities. Concurrently, Section 401 Water Quality Certification would be obtained from Region 6 of the U.S. Environmental Protection Agency.

Prior to the start of construction, a Section 202 Storm Water Pollution Prevention Plan would be prepared by the Federal Government or the construction contractor and a Notice of Intent would be filed with USEPA Region 6. The plan would include the best management practices to be employed to minimize erosion and stormwater runoff from areas disturbed during construction.

6.04 AIR QUALITY AND NOISE

The planned action would not result in any permanent or significant short-term degradation of air quality, although some highly-localized and ephemeral increases in concentrations of dust and combustion emissions would be expected during blasting and the operation of construction vehicles and equipment. Measures to minimize dust, such as surface watering and mulching, would be employed during construction.

Rock material would be obtained from the isolated quarry near the Jemez Canyon Dam project office. Detonations would be expected on a frequency of about one per week. Charges would be contained in bore holes drilled in rock and, therefore, would be muffled. Detonations would be hardly audible at the Hyatt Tamaya Resort, the nearest inhabited area. Prior to detonations, local traffic may be halted in the immediate vicinity of the quarry, and precautions would be taken to inform visitors present at the Jemez Canyon Reservoir overlook site.

Excavated rock would be stockpiled at the quarry area and later crushed to required dimensions. Rock crushing would result in increased noise levels in the immediate quarry area only. During construction of GRF #1, the Bureau of Reclamation successfully utilized the quarry area for rock crushing.

During GRF construction, a slight, localized increase in ambient noise levels would be expected from the operation of equipment adjacent to the Rio Grande.

6.05 ECOLOGICAL RESOURCES

Bars immediately adjacent the channel where GRFs would be installed would be cleared of vegetation to facilitate bankline portions of the structures and construction activities. In all cases, vegetation consists of very sparse salt cedar, with occasional Russian olive or coyote willow shrubs. Approximately one acre along each bank of each GRF would require grubbing, as would one additional acre spanning the location of the bed sill. Therefore, approximately 5 acres would be cleared for the installation of GRFs #2, #3, and the bed sill. (An additional 2 acres would be cleared if GRF #4 is installed.)

Improvement of existing access roads would entail some vegetation removal. A 1.6-mile dirt road trending north-south and lying west of the riparian zone would serve as the main west-side access route and would be widened by approximately 10 feet to safely accommodate construction vehicle traffic. The dry, sandy soils along the alignment support sparse salt cedar and four-wing saltbush. Approximately 1.5 acres of this vegetation would be permanently removed during roadway improvement.

Four relatively short access roads through the riparian zone would be created to afford access to the channel for construction – 3 from the eastside levee and one leading to the west bank of the bed sill location. On the east side of the river, approximately 0.8 acres of sparse salt cedar and Russian olive would be removed for access. Vegetation along the proposed westside access to the bed sill consists of a very dense understory of Russian olive and salt cedar and a mature cottonwood overstory. Approximately 0.8 acres of vegetation removal would be required. All these alignments are within areas to be extensively cleared of nonnative vegetation in future phases of the Pueblo of Santa Ana's master restoration plan. Alignments would be chosen in coordination with the Department of Natural Resources and would avoid patches of native woody species to the extent practicable, and to minimize potential disturbance to root systems of overstory cottonwoods.

(Additional access required to GRF #4 would entail clearing of 0.2 acre of sparse salt cedar between the eastside levee and the channel.)

6.06 ENDANGERED AND PROTECTED SPECIES

Southwestern Willow Flycatcher

Temporary construction impacts: No breeding flycatchers have been located within the proposed project reach. No suitable nor potentially suitable breeding habitat occurs within the project area. It is highly unlikely that the species or its habitat would be harmed by the proposed habitat enhancement activities. It is possible that individual, migrating flycatchers could be displaced up or downstream from the construction area during the fall 2002 migration period.

General long-term impacts: The promotion of channel stability would maintain the possibility of habitat development for the flycatcher, especially along the immediate banks of the channel.

Bald Eagle

Temporary construction impacts: Mature trees adjacent to the channel which may be used by foraging or resting Bald Eagles would not be affected by proposed activities. The proposed construction period (August 2002 - March 2003) would overlap with the Bald Eagle's November-March winter season in New Mexico. Bald Eagles are sensitive to human presence and are expected to traverse the Rio Channel through the active construction areas. This proximity may cause eagles to forage at other locations along the river. To minimize direct disturbance to Bald Eagles, the following precautions would be observed during project construction:

> If a Bald Eagle is present within 0.25 mile (0.4 km) upstream or downstream of the active construction site in the morning before project activity starts, or is present following breaks in project activity, the contractor would be required to suspend all activity until the bird leaves of its own volition; or a Corps biologist, in consultation with the Service, determines that the potential for harassment is minimal. However, if a Bald Eagle arrives during construction activities or if an eagle is greater than 0.25 mile away, construction need not be interrupted.

If Bald Eagles are consistently found in the immediate project area during the construction period, the Corps would contact the Service to determine whether formal consultation under the Endangered Species Act is necessary.

General long-term impacts: Stabilization of the Rio Grande channel through the Pueblo of Santa Ana would assure that this area would continue to be a suitable foraging area for the Bald Eagle in the future.

Rio Grande Silvery Minnow

Temporary construction impacts: The Rio Grande silvery minnow has been collected within the proposed project area, but few have been captured recently. Construction within the river channel would have a direct effect on any individuals present in the area. The Rio Grande silvery minnow, as well as other fish, have the ability to move downstream to safer and less stressful areas. Fish surveys would be conducted prior to and following construction. Active construction would not occur within the spawning period of the silvery minnow.

General long-term impacts: The proposed increase in off-channel habitat with reduced velocities, and the arresting of channel degradation with bed elevation stabilization, are habitat modifications that could provide habitat improvements for the Rio Grande silvery minnow. The substrate would be sandier with new sediment deposition behind the GRFs, resulting in several miles of improved substrate. The GRFs would have 400-foot-long downstream aprons to provide slopes flat enough (0.004 ft/ft) to be negotiated by small native fishes, based on existing riffle slopes in the reach.

To quantify potential long-term benefits to the silvery minnow, the two-dimensional hydraulic model was used to determine the extent of preferred habitat with and without the implementation of the proposed project. Preferred habitat characteristics were based on the descriptions of highly utilized areas in the *Rio Grande Silvery Minnow Recovery Plan* (USFWS 1999a). The plan indicates that silvery minnow were most frequently found in depth ranges of 10 to 30 cm (0.3 to 2.0 feet) and areas where flow velocity was less than 20 cm/sec (0.7 ft/sec). The plan also indicated that minnows tend to shift to deeper water in winter, but those areas were generally typified by lower velocities during this season. The hydraulic model, therefore, was used to determine the extent of area with depths less than 2 feet and velocity less than 1 ft/sec. At the 50%-chance (2-year) discharge of 5,400 cfs, the model indicated that there currently are about 18.6 acres of preferred habitat, and that three GRFs would provide approximately 24 acres. (The area for only two GRFs would be slightly less.) However, with continued channel incision, the future without-project condition would account for only 2.7 acres of preferred habitat. The proposed restoration project would result in substantially more preferred habitat than the future without-project condition over the range of likely discharges (Figure 11).

The predicted future channel degradation below the project area, including directly below the downstream bed sill, could cause a barrier to upstream movement of Rio Grande silvery minnow if a steep vertical drop forms. Therefore, the monitoring of bed sill condition and the maintenance of an acceptable slope will be included in the project's operation and maintenance requirements.

Endangered Species Act Compliance Summary

Based on the analyses and information described above, the Corps has determined that the conduct of the proposed restoration project would not likely adversely affect the Southwestern Willow Flycatcher, Bald Eagle, and Rio Grande silvery minnow. The U.S. Fish and Wildlife Service (USFWS) is currently reevaluating the designation of critical habitat for the silvery minnow along the Rio Grande. Given the benefits to minnow habitat outlined above, the proposed plan would not adversely alter preferred habitat within the project reach, should that area be designated as critical habitat in the future. During informal consultation under the Endangered Species Act, the Corps has requested concurrence from the USFWS regarding their (Corps') "not likely to adversely affect" determination.

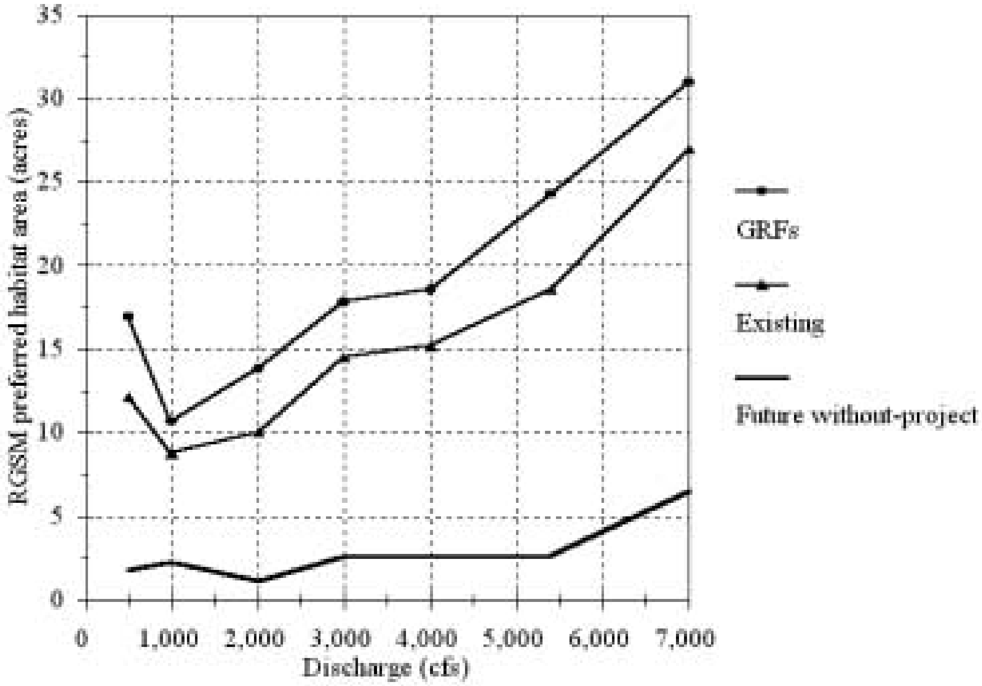

Figure 11. Rio Grande silvery minnow (RGSM) preferred habitat under various conditions.

In June 2001, the USFWS issued to the Corps of Engineers and the Bureau of Reclamation a Biological Opinion concerning discretionary actions related to water management on the Middle Rio Grande (Consultation #2-22-01-F-431). The conduct of habitat/ecosystem restoration projects for the silvery minnow within several reaches of the Rio Grande was included in the opinion's Reasonable and Prudent Alternative. Therefore, Endangered Species Act consultation for the proposed project is tiered to that June 2001 Biological Opinion.

6.07 CULTURAL RESOURCES

The New Mexico Historic Preservation Division’s Archeological Records Management Section database was searched to identify cultural resources sites reported within the vicinity of the project area. The database search found that no archaeological sites have been reported within the river’s 100-year floodplain in the project area. If cultural resources sites were within the 100-year floodplain, they would have been either washed away by the river and/or buried by significant sediment deposition. A recent archaeological survey and assessment that considered the potential for cultural resources to occur within the 100-year floodplain came to the same conclusion: “Based on aerial photo analysis, preliminary geomorphic studies, and field inspection, it became clear that the low terraces within the bosque represent relatively recent historic period alluvial deposits with little or no potential to contain cultural materials of significant antiquity or archaeological integrity.”

(Penner *et al*. 2001). All proposed construction would occur within and immediately adjacent to the river channel; therefore, no cultural resources would be affected by the river restoration project.

No State or National Register properties which could be affected by the restoration project occur within the construction area or along access routes.

The remnant pilings of the Santa Fe Northwestern Railway trestle cross the Rio Grande several hundred feet downstream from the proposed bed sill construction area. The trestle's piling remnants and the railroad grade bed would not be affected by the river restoration project.

The east bank levee and associated service roads would require minor rehabilitation for use as access for construction equipment. Rehabilitation would affect neither the form nor function of the levee. Rehabilitation would cause no impact to the elements that contribute to either the historic character of the levee structure or of its contribution as a structural component of the Middle Rio Grande Conservancy District (MRGCD) system as a whole. Grading and the addition of gravel surfacing may assist in preserving the levee structure. No other MRGCD system structures or features would be affected by the river restoration project.

The May 2001 survey found no artifacts or cultural resource manifestations along the west side access roads. All other access and staging areas including overnight equipment and vehicle parking, quarry, and rock stockpile and spoil areas, have been previously surveyed for cultural resources and received use clearance, have been previously disturbed and utilized for similar purposes, or are located within the 100-year floodplain. In considering the above information and previous survey work, there would be no effect on prehistoric or historic archaeological sites or cultural resources on Santa Ana Pueblo lands or in the general project area.

During project planning, long-time Tribal Administrator, Mr. Roy Montoya, in consultation with tribal members, indicated that no Traditional Cultural Properties would be affected by this river restoration project. No other prehistoric or historic properties or archaeological sites are reported or known to occur near the proposed construction areas and no artifacts or cultural resource manifestations were observed during the site visit to the riverside construction areas.

Therefore, the Corps is of the opinion that there would be "No Historic Properties Affected" by the river restoration project or on the historic and cultural resources of the region. A concurrence of no effect to cultural resources was obtained from the New Mexico State Historic Preservation Officer in July 2001. Consultation with the Pueblo of Santa Ana and the New Mexico State Historic Preservation Officer is documented in Appendix B.

Pursuant to 36 CFR 800.11, should any previously unrecorded and/or previously undetected cultural material be discovered during construction activities, all work will cease in the immediate area of the exposed resource until the significance and disposition of the archaeological remains have been evaluated, and a determination of significance made in consultation with the Pueblo of Santa Ana and the New Mexico State Historic Preservation Officer.

6.08 LAND USE AND RECREATIONAL RESOURCES

Land use within the project area would not be altered by the proposed project. The area would remain a designated natural preserve.

Approximately 500 feet of screening material/fencing would be installed to screen the view of the staging area from the nearby Hyatt Tamaya Resort. During construction, public access would be restricted from the staging and construction areas. Visitors to the area would still be afforded access to the adjacent bosque and river channel.

Some secondary benefits to recreational activities in the project area would result from the proposed plan. Stabilization of the channel would preserve the current ecological functions, values and esthetics.

6.09 SOCIO-ECONOMIC CONSIDERATIONS

The proposed restoration project would not affect economic enterprise at the Pueblo of Santa Ana Reservation or in Sandoval County.

7. RECOMMENDATION

As District Engineer, Albuquerque District, U.S. Army Corps of Engineers, I have weighed the ecosystem benefits to be gained from implementing the recommended habitat restoration plan at the Pueblo of Santa Ana Reservation against the cost, and have considered the alternatives, impacts, and scope of the proposed project. In my judgment, the proposed project is a justified expenditure of Federal funds. The proposed project is fully consistent with the authorized purposes of Jemez Canyon and Cochiti Dams and would not have any effect on their operation or maintenance. I recommend that the Secretary of the Army approve the Riparian and Wetland Restoration Project at the Pueblo of Santa Ana Reservation.

Total estimated first cost of the project is $6,666,000. The project sponsor, the Pueblo of Santa Ana, would provide one-quarter, that is $1,666,000, of the total project cost, thus meeting the requirement of 25% non-Federal money for Section 1135(b) program (Public Law 99-662) projects. All future operation and maintenance responsibilities for the structures and features implemented in the recommended plan would be borne by the Pueblo of Santa Ana. These and other pertinent details have been included in the draft Project Cooperation Agreement negotiated with the sponsor.

I further recommend that funds in the amount of $1,000,000 be allocated in fiscal year 2002 to complete plans and specifications and initiate construction.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of restoration projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted as proposals for implementation funding. However, prior to transmittal, the sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

for Gregory J. Gunter
Major, EN
Acting District Engineer

8. PREPARATION, COORDINATION AND CONSULTATION

8.01 PREPARATION

This Detailed Project Report / Environmental Assessment was prepared by the U.S. Army Corps of Engineers, Albuquerque District. The Product Delivery Team and principal preparers included:

William DeRagon – Project Manager/Biologist
Kelly Alcon – Real Estate Appraiser
Alan CdeBaca – Cost Estimator
Darrell Eidson, P.E. – Hydraulic Engineer
Gregory Everhart – Archaeologist
Brian Jordan – Chemist
Art Maestas – Geotechnical Engineer
Will Trujillo, P.E. – Civil Engineer

The Albuquerque District Independent Technical Review Team consisted of:

Ben Alanis, P.E. – Design Branch
Jesus Barrios – Cost Engineering
Carolyn Brumfield, P.E. – Hydrology and Hydraulics Section
Mark Harberg – Project Management, Civil Works
Ernest Jahnke – Environmental Resources Branch
John Schelberg, Ph.D. – Archaeologist
Doug Wolf, P.E. – Hydrology and Hydraulics Section

Ayres Associates (Fort Collins, CO) conducted geomorphic, hydrologic, and hydraulic analyses which formed the basis of all findings, and performed the hydraulic design:

Peter Lagasse, P.E. – Senior Vice President
Lyle Zevenbergen, Ph.D, P.E. – Hydraulic Engineer
Morgan Byars, P.E. – Hydraulic Engineer
Scott Hogan, P.E. – Hydraulic Engineer

The U.S. Fish and Wildlife Service provided valuable input to the consideration of alternatives through the Fish and Wildlife Coordination Act Report (Appendix A):

Joy Nicholopoulos, Ph.D. – New Mexico State Supervisor
Brian Hansen – Assistant New Mexico State Supervisor
Denise Smith – Biologist

The staff of the Pueblo of Santa Ana were, of course, instrumental in the planning, coordination, and technical activities associated with this study:

Todd Caplan – Restoration Program Manager, Dept. of Natural Resources

John Cote – Director, Department of Natural Resources
Les Ramirez – Counsel and Federal projects facilitator
Roy Montoya – Tribal Administrator

The U.S. Bureau of Reclamation, Albuquerque Area Office, contributed substantively to the planning, hydraulic analyses, and design of the preferred plan.

8.02 COORDINATION AND CONSULTATION

Agencies and other entities contacted formally or informally in preparation of this Environmental Assessment included:

New Mexico Environment Department
Pueblo of Sandia
U.S. Army Corps of Engineers, Regulatory Branch
U.S. Bureau of Reclamation, Albuquerque Area Office
U.S. Environmental Protection Agency, Region 6
U.S. Fish and Wildlife Service, New Mexico Ecological Services Office

The planned action has been fully coordinated with the U.S. Fish and Wildlife Service (Service) in compliance with the Fish and Wildlife Coordination Act of 1958. The final Fish and Wildlife Coordination Act Report prepared by the USFWS is included in Appendix A. Consultation with the Service under the Endangered Species Act is documented in Appendix B.

Coordination under Section 106 of the National Historic Preservation Act has been conducted with the New Mexico State Historic Preservation Officer (SHPO). A letter of concurrence of no effect to cultural resources was issued in July 2001, and is included in Appendix B.

8.03 PUBLIC REVIEW

The draft Detailed Project Report / Environmental Assessment was made available for public review from January 18 through February 1, 2002. Availability was advertised in The Albuquerque Journal (January 18 and 20), The Albuquerque Tribune (January 18 and 21), The Santa Fe New Mexican (January 21 and 25), and The Observer (Rio Rancho; January 18 and 25).

Paper copies of the document were made available for review at: Albuquerque Public Library, Main Branch, 501 Copper Ave. NW, Albuquerque; Bernalillo Roosevelt Public Library, 134 Calle Malinche, Bernalillo; Esther Bone Memorial Library, 950 Pinetree Road, Rio Rancho; La Farge Public Library, 1730 Llano St., Santa Fe; Pueblo of Santa Ana, Department of Natural Resources, 221 Ranchitos Rd., Bernalillo; and the U.S. Army Corps of Engineers, Albuquerque District office. Digital copies were available from the Albuquerque District webpage.

No public or agency comments were received.

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